NAVMC ELECT-2008

INSTRUCTION BOOK

for

MULTIMETER ME-25A/U

Manufactured by

CRESCENT COMMUNICATIONS CORP.

81 Hamilton Street

New London, Conn.

U. S. MARINE CORPS

Contract NOM-67089 *Approved by U. S. Marine Corps*

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CONTRACTUAL GUARANTEE

The Contractor guarantees that at the time of delivery thereof the articles provided for under this contract will be free from any defects in material or workmanship and will conform to the requirements of this contract. Notice of any such defect or nonconformance shall be given by the Government to the Contractor within one year of the delivery of the defective or nonconforming article, unless a different period of Guaranty is specified in the schedule. If required by the Government within a reasonable time after such notice, the Contractor shall, with all possible speed, correct or replace the defective or nonconforming article or part thereof. When such correction or replacement requires transportation of the article or part thereof, shipping costs, not exceeding the usual charges, from the delivery point to the Contractor's plant and return, shall be borne by the Contractor; the Government shall bear all other shipping costs. This Guaranty shall then continue as to corrected or replacing articles or, if only parts of such articles are corrected or replaced, to such corrected or replacing parts, until one year after the date of redelivery, unless a different period of Guaranty is specified in the schedule. If the Government does not require a correction or replacement of a defective or nonconforming article, the Contractor, if required by the contracting officer, within a reasonable time after the notice of defect or nonconformance, shall repay such portion of the contract price of the article as is equitable in the circumstances.

REPORT OF FAILURE

Report of failure of any part of this equipment, during its entire service life, shall be made to EMAC in accordance with current regulations using form DD-787-1. The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures see cover of FAILURE REPORT book.

ORDERING PARTS

All requests or requisitions for replacement material should include the following data:

1. Signal Corps stock number.
2. Name and short description of part.

If the appropriate stock number is not available, the following shall be specified:

1. Equipment model or type designation, circuit symbol, and item number.
2. Name of part and complete description.
3. Manufacturer's designation.
4. Contractor's drawing and part number.
5. JAN or Navy type number.

SAFETY NOTICE

The use of this equipment involves voltages which are dangerous and may be fatal if contacted by operating personnel. Extreme caution should be exercised when working on equipment employing high voltages.

While every practicable safety precaution has been incorporated in ship and shore electronics equipment, the following rules must be strictly observed:

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high voltage supply on. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors. To avoid casualties always remove power and discharge and ground circuits prior to touching them.

DON'T SERVICE OR ADJUST ALONE.

Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

DON'T TAMPER WITH INTERLOCKS.

Do not depend upon door switches or interlocks for protection but always shut down motor generators or other power equipment. Under no circumstances should any access gate, door, or safety interlock switch be removed, short-circuited, or tampered with in any way, by other than authorized maintenance personnel, nor should reliance be placed upon the interlock switches for removing voltages from the equipment.

RESUSCITATION

AN APPROVED POSTER ILLUSTRATING THE RULES FOR RESUSCITATION BY THE PRONE PRESSURE METHOD SHALL BE PROMINENTLY DISPLAYED IN EACH RADIO, RADAR, OR SONAR ENCLOSURE.

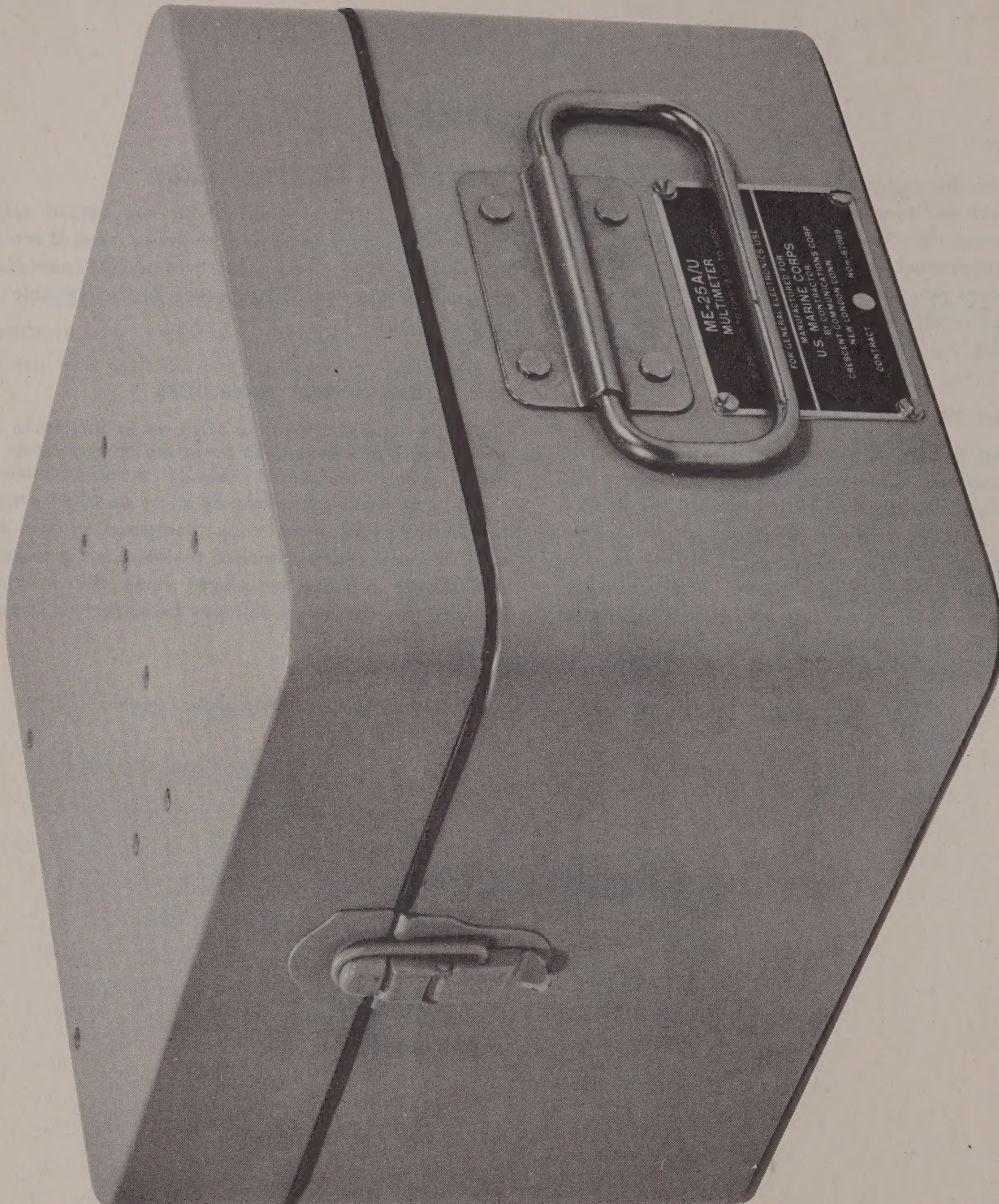


Figure 1-1. Multimeter ME-25A/U with Cover in Place

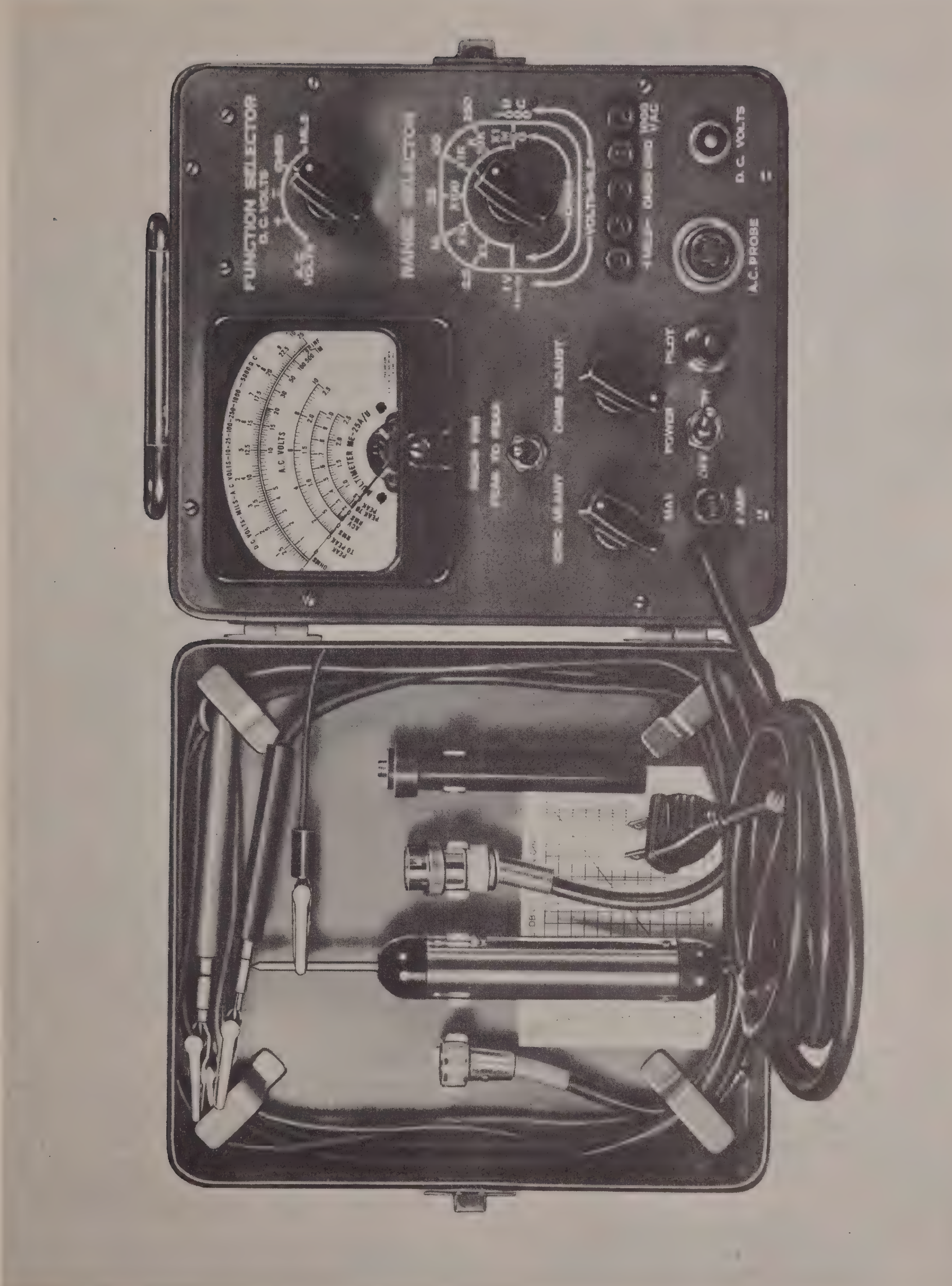


Figure 1-2. Multimeter ME-25A/U and Accessories

SECTION I
GENERAL DESCRIPTION

1. PURPOSE.

Multimeter ME-25A/U is a portable combination electronic AC voltmeter for measurement of peak-to-peak and RMS voltages; DC voltmeter, ohmmeter and milliammeter which can be advantageously used wherever it is necessary to make current, resistance and voltage measurements with the use of only one instrument. Circuit design permits measurements to well over 100 mc with the accuracy and the high impedance input of an electronic DC voltmeter and electronic ohmmeter. In addition, current measurements up to 1000 milliamperes may be made.

2. BRIEF DESCRIPTION.

a. PHYSICAL.—Multimeter ME-25A/U, as shown in Figure 1-1, has a Marine Corps green case and panel with white designations. All switches and connectors are clearly designated and the large meter has scales easily readable. The case is furnished with a steel bail-type handle at one end and four extruded metal feet at the other. A special compartment for carrying and storing all cables and test leads is in the cover.

The AC power line cord is permanently attached. In addition, five separate leads and a special high voltage adapter are also furnished. Two 48″ unshielded leads are furnished for making resistance, current and 1000 volt AC measurements. One of these leads is red with a plug tip on one end and a red test prod with screw-on alligator clip on the other. The other lead, ground, is black and has a plug tip on one end and a black test prod with screw-on alligator clip on the other.

A shielded test lead with a single contact microphone connector on one end and a test prod, incorporating a 3.3 megohm isolating resistor, on the other, is furnished for DC voltage measurements. A special high voltage adapter incorporating a 53.2 megohm resistor is furnished for use in conjunction with the shielded DC test lead when utilizing the 5000 volt DC range.

An AC probe and shielded cable assembly is furnished for making AC voltage measurements up to 250 volts. This cable is 48″ long with a microphone connector on one end and the special AC probe on the other. The rectifier is housed in the probe. In addition to this, a 5″ black ground lead is furnished with an alligator clip on one end and a threaded tip on the other which is connected directly into the special AC probe, and used as a ground connection when measuring frequencies above 50 mc. When measuring 1000 volts AC, use the 1000 VAC jack on the front panel of the instrument.

b. FUNCTIONAL.—Multimeter ME-25A U is designed to perform all the electrical functions of an instrument of its type with the light loading effect of a high impedance input:

(1) It will measure direct currents up to 1000 milliamperes.

(2) It will measure resistance up to 1000 megohms.

(3) It will measure DC voltages up to 5000 volts.

(4) It will measure AC voltages up to 250 volts with a special AC probe and cable assembly, and 1000 volts through the 1000 VAC jack on the front panel.

c. ELECTRICAL.—The basic principle of the meter circuit is an electronic bridge similar to the Wheatstone bridge in principle with the resistance of two arms being the resistance of two triode sections of a type 12AU7 tube. The meter is electrically balanced across the tube by the remainder of the meter circuit without input. Input to the grid of a tube effectively unbalances the circuit and causes the meter to read. Input to the grid is through a voltage dividing network. An AC probe is used to rectify the AC for AC voltage measurements. A dry battery is used as a source of DC for ohmmeter measurements. The milliammeter circuit is of standard design.

3. REFERENCE DATA.

a. Nomenclature: Multimeter ME-25A U, Electronic Volt-Ohm-Milliammeter.

b. Contract Number: NOM-67089. Date: 21 December 1954.

c. Contractor: Crescent Communications Corp.

d. Cognizant Naval Inspector: Inspector of Naval Material, Bridgeport, Conn.

e. Number of Packages Involved per Complete Shipment of Equipment, Including Spare Parts Boxes: One.

f. Total Cubical Content: Crated: 3291 cu. in.
Uncrated: 541 cu. in.

g. Total Weight: Crated: 41 lbs.
Uncrated: 13 lbs.

h. Frequency Range: 50 cycles to 100 mc.

i. Characteristics of Power Supply Required for Operation:

(1) Voltages: 105-125 volts, 50-1600 cycles AC.
1.5 volts, DC (one self-contained dry battery BA-30, not supplied with equipment.)

(2) Current Drain per Each Voltage Supply: Ohmmeter: 0.3 amperes, maximum.

j. Input Impedance:

(1) DC: 13.3 megohms,
with test prod MX-1101/U, 66.5 megohms.

(2) AC: 16 mmf shunted by more than 13 megohms with AC probe.
10 mmf shunted by 5 megohms on 1000 V. A.C. range.

k. Power Consumption: 12 watts at 115 volts.

l. Overall Accuracies:

(1) D-C Current Ranges: ±3% of full scale.

(2) D-C Voltage Ranges: (four lower ranges) ±4% of full scale.

(3) D-C Voltage Ranges: (250, 1000 and 5000 volts) ±5% of full scale.

(4) A-C Voltage Ranges: ±5% of full scale.

(5) Ohmmeter Ranges: within 3° of arc from absolute value of resistance indicated on meter scale.

m. Special Features of Multimeter ME-25A/U:

Features found in the ME-25A/U not found in the earlier ME-25/U or OBQ series instruments are as follows:

(1) Indications based on peak-to-peak value of the AC voltage being measured, and calibrated in terms of peak-to-peak and RMS value.

(2) Additional RMS AC voltage range of 1000 volts.

(3) High voltage DC extension probe which increases the DC range to 5000 volts.

(4) A 0-1 volt RMS range.

The Model OBQ series did not have an enclosing cover for the case, but had a separate compartment for the leads in the case.

4. EQUIPMENT DATA.

TABLE 1-1. EQUIPMENT SUPPLIED

QUANTITY PER EQUIP-MENT	NAME OF UNIT	OVERALL DIMENSIONS A—CRATED B—UNCRATED HEIGHT—WIDTH—DEPTH	VOLUME A—CRATED B—UNCRATED	WEIGHT A—CRATED B—UNCRATED
1	Multimeter	A: 13½″ x 12½″ x 19½″ B: 9¾″ x 7⅞″ x 6⅝″	A: 3291 cu. in. B: 541 cu. in.	A: 41 lbs. B: 13 lbs.
1	A-C Probe and Cable Assembly	48″		
1	Ground Lead	48″		
1	Test Lead—Shielded	48″		
1	Test Lead—Unshielded	48″		
1	Ground Lead	5″		
1	High Voltage Adapter	5-3/16″ long, ⅝″ dia.		

TABLE 1-2. REQUIRED BUT NOT SUPPLIED

QUANTITY PER EQUIPMENT	NAME AND DESCRIPTION
1	Dry Battery, BA-30
1	Power Supply Source, 105-125 volts, 50-1600 cycles, AC

5. TUBE COMPLEMENT.

TABLE 1-3. TUBE COMPLEMENT

TUBE	TYPE	FUNCTION
V-101	12AU7	Bridge Circuit
V-102	6X4	Power Rectifier
V-103	6AL5	A-C Probe Rectifier

SECTION 2
THEORY OF OPERATION

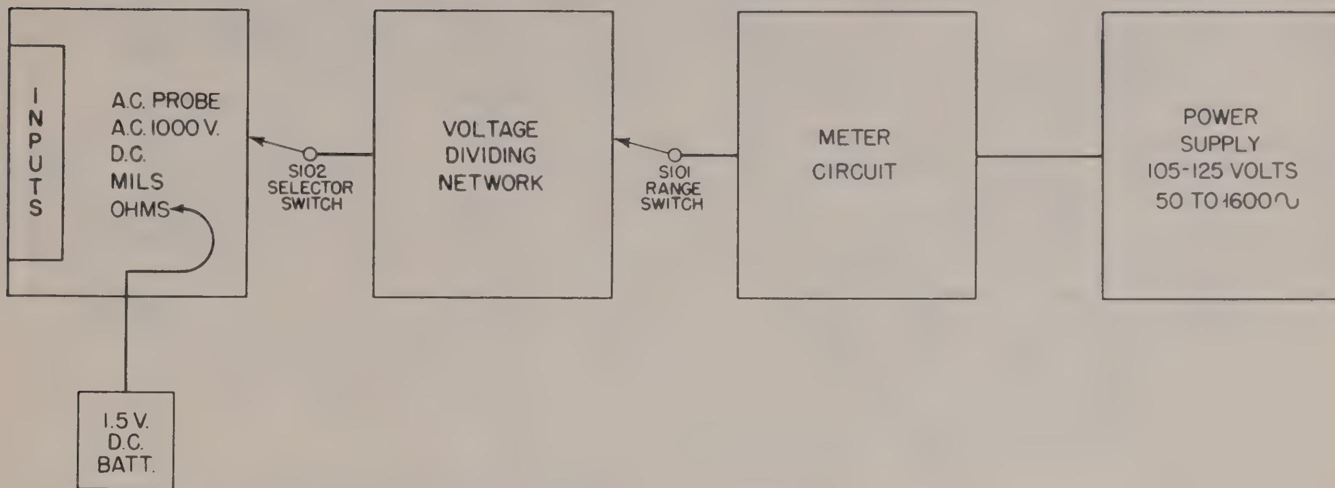


Figure 2-1. Basic Circuits in Block Form

1. GENERAL.

During the following discussions, reference to the block diagram of Multimeter ME-25A/U, Figure 2-1, and the schematic wiring diagram, Figure 6-13, will facilitate the understanding of the basic operation of the circuits used in this equipment.

a. METER CIRCUIT. *(See Fig. 2-2)*

A type 12AU7 tube, V101, is connected in an electronic bridge circuit, and with voltages applied to either grid, the deflection of the meter which is connected in the plate circuits will be proportional to the DC voltage applied to the grid.

b. DC VOLTMETER CIRCUIT. *(See Fig. 2-3)*

The input to the DC voltmeter circuits is taken through the DC probe incorporating an isolating resistor, and applied through the RANGE SELECTOR network to the metering circuit.

c. AC VOLTMETER CIRCUIT. *(See Fig. 2-4)*

AC voltages up to 250 volts are applied to the RF probe utilizing a type 6AL5 tube connected in a voltage doubling circuit. The DC voltage which results from the rectification of the AC voltage in this probe is applied through the RANGE SELECTOR network to the metering circuits in the same manner that the DC voltage is applied. Calibration of the meter circuits is such that the indication will be based on the peak-to-peak value of the AC voltage being measured, but calibrated in terms of either its RMS or peak-to-peak value.

For measurements on the 1000 volt AC range the voltage is applied to, and rectified by, a type 1N34 crystal. The RF probe is not used for these measurements.

d. OHMMETER CIRCUIT. *(See Fig. 2-6)*

A self-contained 1.5 volt dry battery is used in connection with a voltage dividing network to permit the measurement of resistances throughout the range of the equipment. The voltage output from this dividing network is applied to the metering circuits and the indication made proportional to the value of the resistance being measured.

e. MILLIAMMETER CIRCUIT. *(See Fig. 2-7)*

Milliampere measurements are made by conventional means of measuring the millivolts drop across calibrated shunts with the meter indicating in terms of milliamperes for the various ranges.

f. POWER SUPPLY CIRCUIT. *(See Fig. 2-8)*

A type 6X4 tube, V102, is connected as a full-wave rectifier and supplies DC operating potentials for the metering circuit. A 6.3 volt filament winding is employed for supplying all heater voltages. The primary of the transformer is fused by means of F101 located on the front panel.

2. CIRCUIT ANALYSIS.

a. BASIC METER CIRCUIT.

Figure 2-2 illustrates the basic meter circuit used for all measurements except DC MILS and 0-1000 VOLTS AC. A twin-triode V101, type 12AU7, is electrically connected as shown. With no voltage on either grid, ZERO ADJUST control R109 is set so that the meter reads zero. In operation, one of the grids is always grounded and a voltage applied to the opposite grid. Assume a case where grid No. 2 is grounded and a negative voltage applied to grid No. 1. This will cause a decrease in current through triode

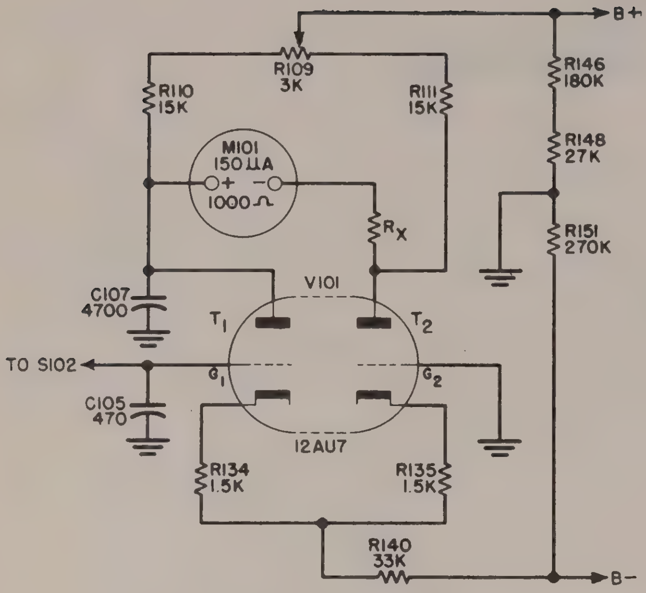


Figure 2-2. Basic Meter Circuit

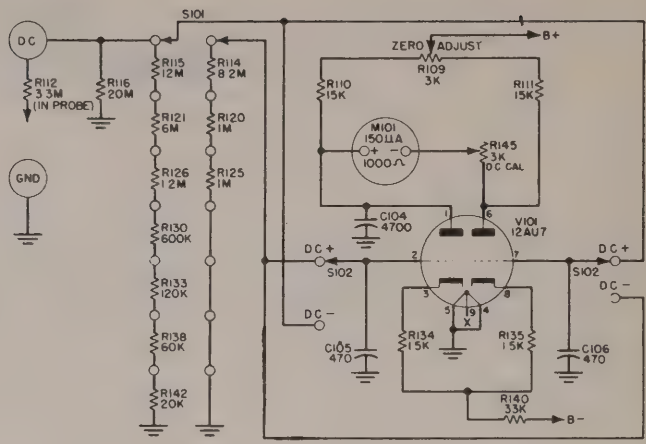


Figure 2-3. DC Voltmeter Circuit

T1. As a result, the voltage applied to the meter from the plate through R110 will increase. At the same time, the voltage across common cathode resistor R140 will decrease. When the voltage across R140 decreases it also effectively decreases the potential of the cathode of triode No. T2. This is effectively the same thing as a positive increase of grid No. 2 which is maintained at ground potential, causing triode T2 to draw more current. When T2 draws more current its plate goes more negative with respect to its potential when no voltage is being applied to the measuring circuits. As a result of the combination of the plate of T1 going more positive and plate of T2 going more negative, an unbalance exists and current is forced through the meter in such a direction as to make it read up scale. In the same manner, if grid No. 1 had been maintained at ground potential and a positive voltage applied at grid No. 2, the same action would take place causing the meter to read up scale. If a positive voltage were applied to grid No. 1, or a negative voltage applied to grid No. 2, the meter would read in a reverse direction.

R_x as indicated in Figure 2-2, is an adjustable calibrating resistor. A separate potentiometer is used in place of R_x for calibration of AC volts RMS, AC volts peak-to-peak, DC volts and ohms measurements.

b. DC VOLTMETER CIRCUIT.

DC voltages up to 1000 volts are applied directly through the DC probe illustrated in Figure 2-3. This probe carries an isolating resistor of 3.3 megohms, R112, to prevent capacity loading of the circuits under test. For 5000 volt DC measurements the voltage extension probe, MX-1101/U (E114), illustrated in Figure 3-4, is screwed on the end of the regular DC probe. This high voltage probe contains an isolating and voltage dropping resistor of 53.2 megohms. Voltages to be measured are applied from the probe to the high end of the voltage dividing network on RANGE SELECTOR switch S101. Voltages from this network are taken to grid pin 7 of V101 for measurements of DC voltages positive with respect to ground, and to pin 2 of V101 for measurements of voltages negative with respect to ground.

The voltage dividing network of S101 is shunted to ground by means of R116, a 20 megohm resistor, as the sensitivity of the measuring networks is such that this value of resistance is required to effect proper calibration. An additional section is used on S101 and comprises R114, R120 and R125 which are used respectively on the 1, 2.5 and 10 volt ranges. The purpose of these resistors is to permit a small amount of contact potential to be developed on the grid which is not being used in connection with the main voltage dividing network section of S101. Figure 2-3 illustrates that the unused or inactive grid is connected to the slider arm on this section of the switch. Both grids, pins 2 and 7, are bypassed to ground by C105 and C106 respectively. The purpose of these bypass condensers is to prevent any possible stray AC which might be picked up and fed to the grids affecting the calibration of the equipment.

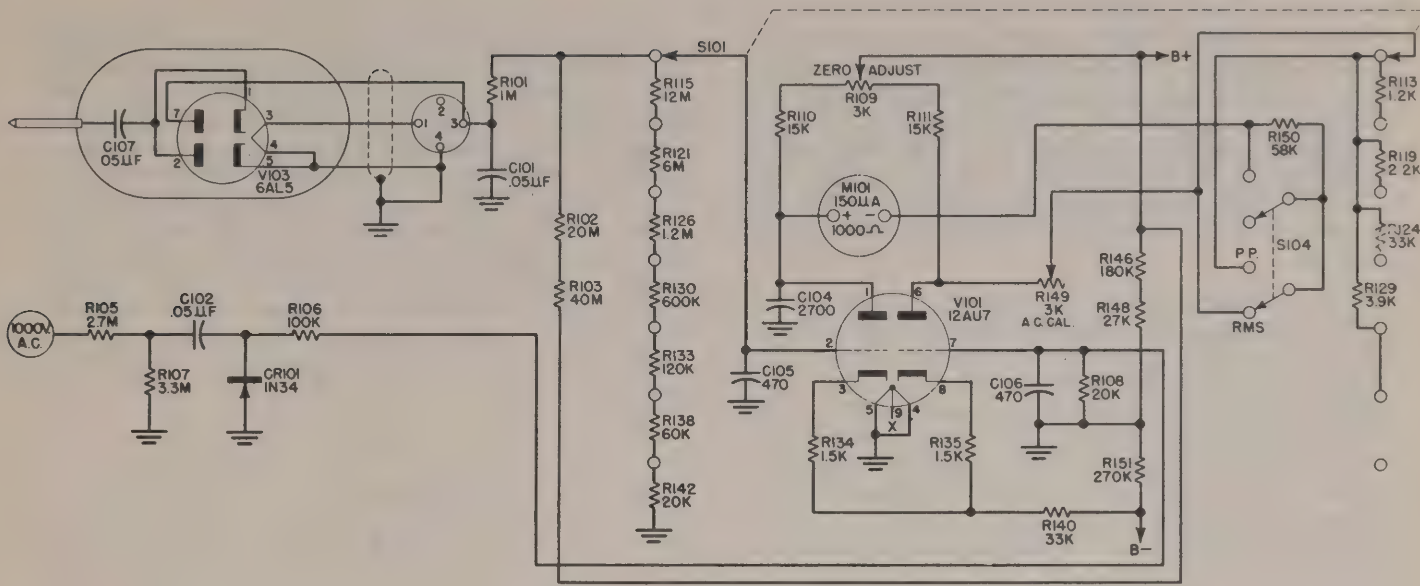


Figure 2-4. AC Voltmeter Circuit

c. AC VOLTMETER CIRCUIT.

With reference to Figure 2-4, there are two inputs for AC voltage measurements, one through the voltage doubling probe circuit utilizing a type 6AL5 tube, V103, which serves for measurements up to 250 volts throughout a frequency range of approximately 20 cycles to over 100 mc. In the case of the input to the 1000 volt range, the frequency limits are from 50 to 3000 cycles approximately. At 12,000 cycles the error is approximately 5%.

Figures 2-5A and 2-5B illustrate the electrical circuits which provide for the indication of the indicating meter to be proportional to the peak-to-peak value of the AC voltage being measured. In the case illustrated, it is assumed that the voltage being measured is 10 volts RMS. This corresponds to a peak voltage in each direction of 1.4 times 10, or 14 volts peak. In the case of Figure 2-5A it is assumed that the voltage delivered to one-half of the dual diode V103A is positive with respect to ground. During the first half cycle C107 is charged to this peak value of 14 volts as illustrated in Figure 2-5A. It is assumed that the charge on C107 remains at 14 volts during the next half cycle which is illustrated in Figure 2-5B. During this half cycle in which the applied voltage to the diode is negative with respect to ground, the 14 volts is additive to the 14 volts already appearing on C107, causing C101 to become charged to a total of 28 volts negative with respect to ground. This DC voltage is applied through decoupling resistor R101 to the high side of the voltage dividing network of the RANGE SELECTOR switch S101. A bucking voltage is also applied at this junction from the B+ supply through resistors R102 and calibrating resistor R103, in series. R103 is so adjusted that the voltage from the B+ supply effectively bucks out the contact potential voltage developed at plate pin 7 of V103. As a result of this, when changing ranges it is generally not necessary to appreciably have to readjust ZERO ADJUST control R109.

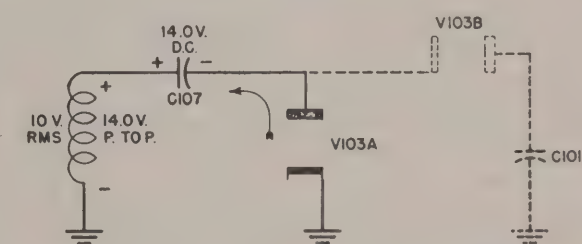


Figure 2-5A. Electrical Circuit, Positive with Respect to Ground.

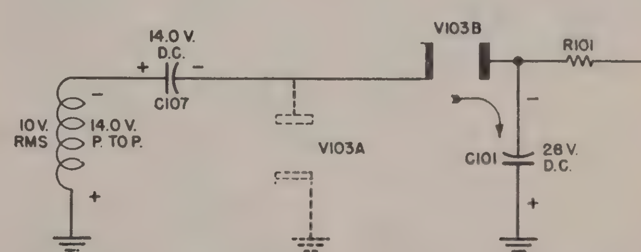


Figure 2-5B. Electrical Circuit, Negative with Respect to Ground

Voltage from RANGE SELECTOR switch S101 is applied to grid pin 2 of the vacuum tube voltmeter tube V101. Condenser C105 connected from this grid to ground serves as a filtering network for any possible AC which might be picked up by the preceding circuits. Grid pin 7 of V101 is returned to ground through R108, bypassed by C106. The purpose of R108 is to serve only as part of the voltage dividing network when the 1000 volt AC range is being used. With the meter M101 effectively connected between

the two plates of V101, pins 1 and 6, and with no voltage applied, the ZERO ADJUST control R109 is so adjusted that the meter indicates zero. As AC voltages are applied the corresponding negative DC voltage is applied at grid pin 2 of V101, causing an unbalance in the bridge circuit of V101, and resulting in a corresponding increase in current through meter M101 which is calibrated in terms of applied AC voltage.

When switch S104 is operated to the PEAK-TO-PEAK position, the meter is calibrated in terms of the peak-to-peak value of the applied voltage. The negative side of the meter is effectively connected through the range calibration resistors R113, R119, R124 or R129, on ranges 1, 2.5, 10, 25, 100 and 250 respectively, through AC calibration potentiometer R149, to the plate pin 6 of V101. When S104 is operated for RMS indication, the meter is returned directly through R150 to calibration potentiometer R149 and to plate pin 6 of V101.

In making voltage measurements on the 1000 volt AC range, the meter indication is proportional to the average value of the applied AC voltage, but calibrated in terms of its RMS value. This voltage is applied through a dividing network consisting of R105 and R107 through C102, a DC blocking condenser, to rectifier CR101, a type 1N34 crystal. The rectified voltage from the anode of CR101 is taken through decoupling resistor R106 to grid pin 7 of V101. This grid is returned to ground by dividing network resistor R108 and is bypassed to ground by C106.

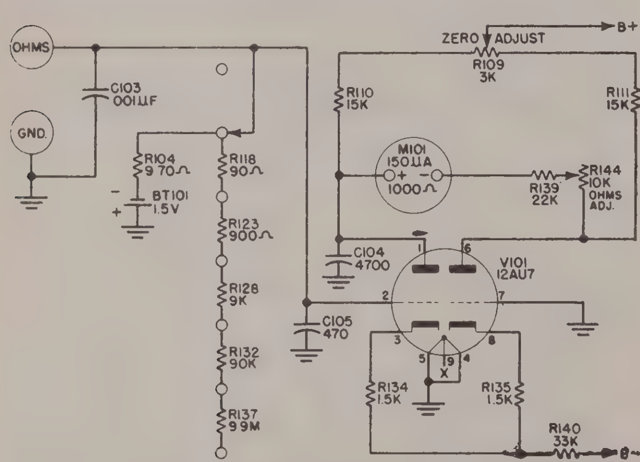


Figure 2-6. Ohmmeter Circuit

d. OHMMETER CIRCUIT.

On the main panel two pin jacks are used for connection of external resistances to the resistance measurement circuit of the ohmmeter section. Pin 7 of the vacuum tube voltmeter tube, V101, is operated at ground potential and grid pin 2 is fed from the 1.5 volt battery BT101 through a series of calibration resistors on the OHMS section of the RANGE SELECTOR switch. With no resistance connected externally, grid pin 2 is operated at a negative potential of 1.5 volts, regardless of the range being used. Under this condition the OHMS ADJUST control R144, located on the panel, is operated to bring the meter to full scale, or infinity ohms. With the ohms input circuit short-circuited, the ZERO-ADJUST control is operated to cause the indicator to read at the extreme left, or zero ohms. With an unknown resistor connected across the OHMS and GND input terminals and the RANGE SELECTOR switch operated to the proper range, a voltage will appear at pin 2 of V101. The meter M101 is calibrated in terms of the unknown resistance by virtue of the fact that the voltage appearing at the grid is proportional to this external resistance.

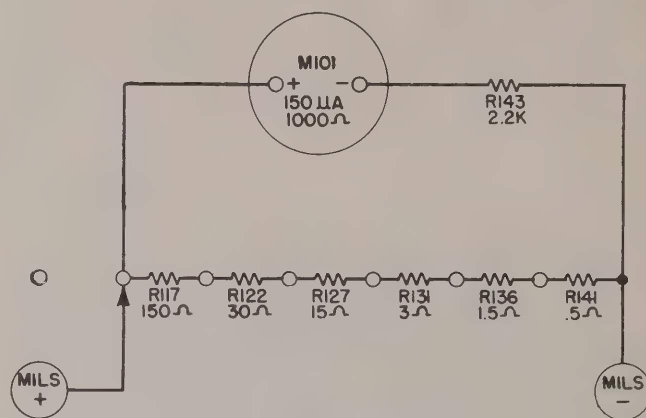


Figure 2-7. Milliammeter Circuit

e. MILLIAMMETER CIRCUIT.

The milliammeter, as shown in Figure 2-7, is of the conventional type and will measure up to 1000 milliamperes. The circuit is so designed that as the higher ranges are used the effective internal resistance is decreased. To avoid possible damage to the meter, always start with the highest range.

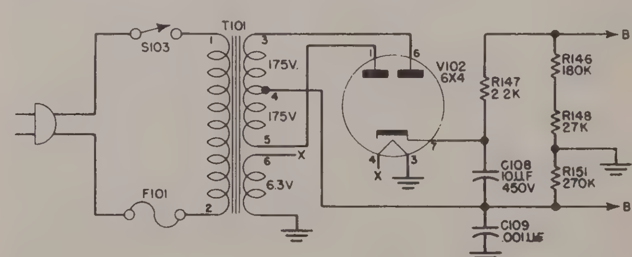


Figure 2-8. Power Supply Circuit

f. POWER SUPPLY CIRCUIT.

All voltages, with the exception of the 1.5 volt battery BT101, for the operation of Multimeter ME-25A/U are obtained from the power supply utilizing T101. The primary of this transformer is connected to the power supply line cord through fuse F101 located on the front panel, and also through S103, the POWER OFF-ON switch, also located on the front panel.

The transformer has two secondary windings, one of 350 volts center-tapped, which is fed to the rectifier tube V102, type 6X4, connected for full-wave rectification. The DC output from this tube is filtered by C108 and the negative side bypassed to the chassis by C109. The DC output is further filtered by R147 and applied to a network consisting of R146 and R148 in series from B+ to ground, and R151 from B— to ground. The DC voltage developed across this network is approximately 150 volts. A 6.3 volt secondary winding is also provided for the operation of all heaters of the tubes used.

The instrument is nominally designed to operate on a supply line of 50 to 60 cycles, 105 to 125 volts, but in an emergency can be operated from a power source with a frequency up to 1600 cycles.

SECTION 3

INSTALLATION AND ADJUSTMENT

1. INSTALLATION.

a. HOUSING.—Multimeter ME-25A/U is housed in a case consisting of the main body with a cover secured in place by slip hinges and one draw bolt. Suitable brackets and fasteners are secured within the cover to provide for storage of the operating cables, AC probe, DC extension probe and line cord. A rubber gasket is also provided between the main body and the cover. (See Fig. 3-3)

b. UNPACKING.—As shipped, each equipment is packed in a substantial wooden case which is sufficiently sturdy and affords sufficient protection to the equipment to permit it to remain exposed to the weather for an indefinite time. When opening the packing case and removing the equipment (see Fig. 3-2), care should be taken not to dent or otherwise damage the metal housing of the equipment.

c. OPERATING LOCATION.—In general, with very few exceptions, any location where suitable AC input power is available will be a satisfactory operating location for the equipment.

Note

The equipment has been designed to operate equally well in any convenient operating position, although it is characteristic of electrical indicating meters of high sensitivity to exhibit less pivot friction when operated with the pivots vertical. In this position the face of the meter is horizontal.

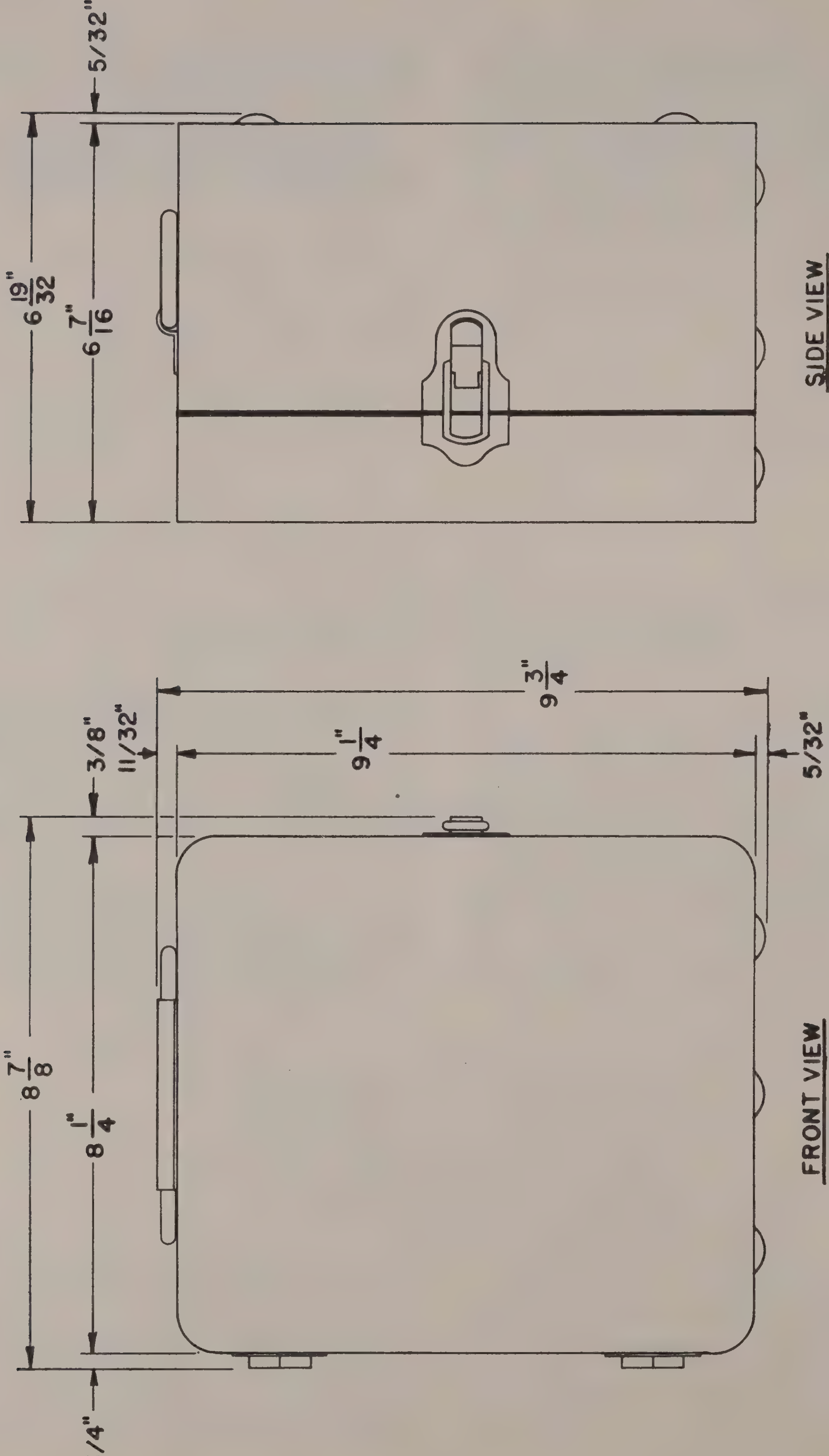


Figure 3-1. Overall Outline Dimensions of Multimeter ME-25A/U

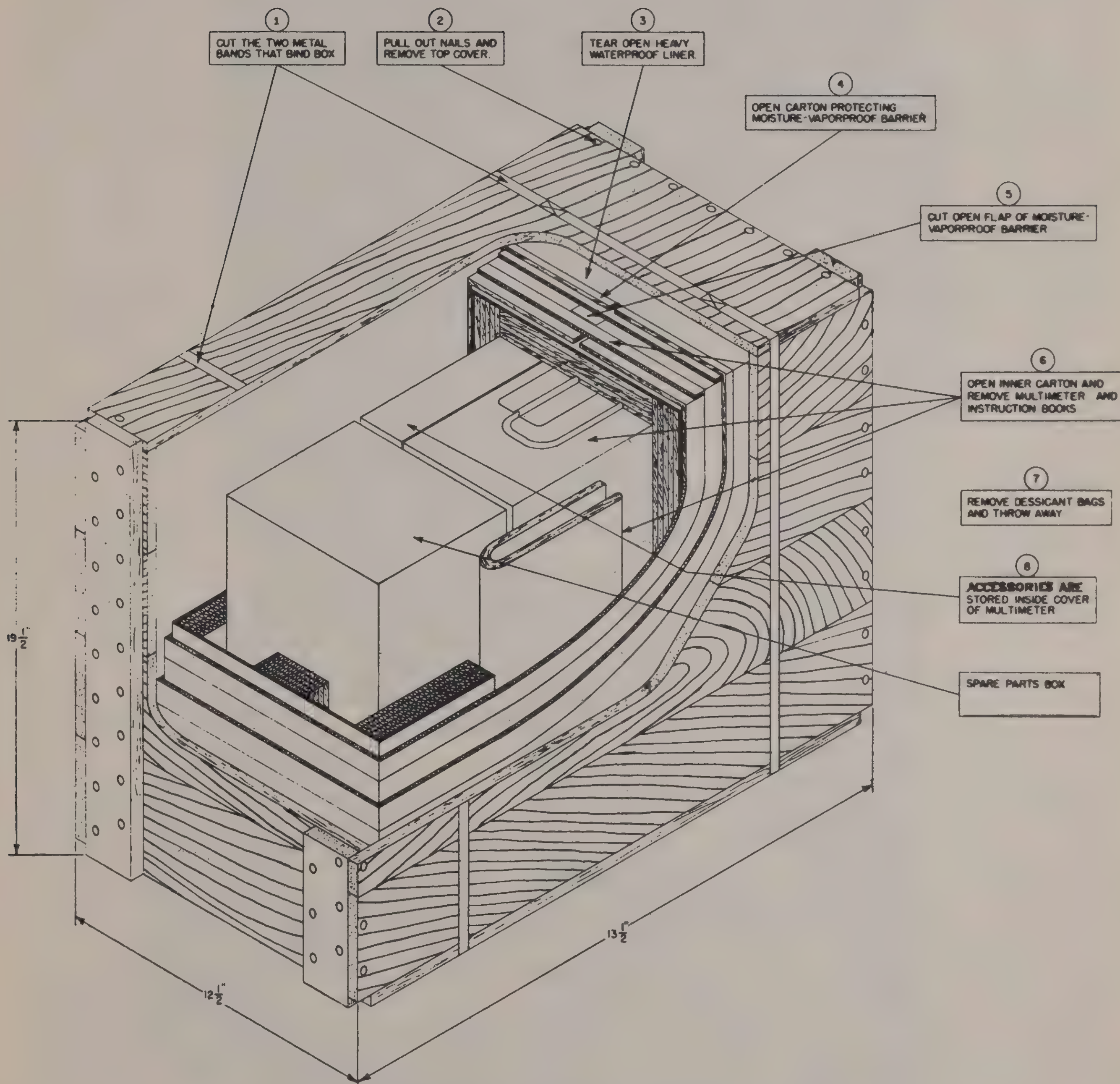


Figure 3-2. Cutaway View of Export Packaging

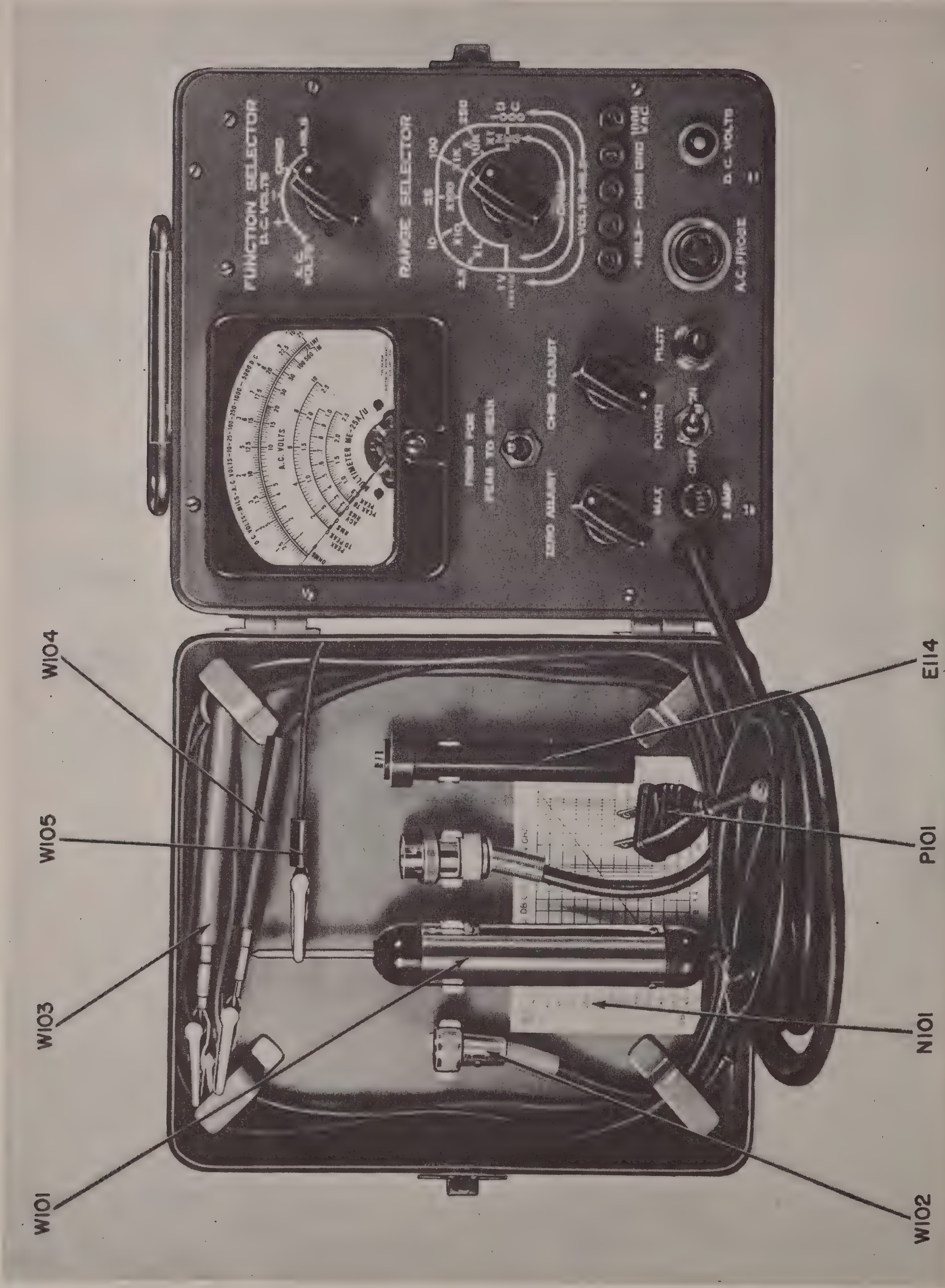


Figure 3-3. Multimeter ME-25A/U with Cable Compartment in Cover

d. ATTACHING OPERATING CABLES.

(1) AC LINE CORD—A 6-foot AC line cord is permanently attached to the instrument and contains a standard 2-prong male AC line plug on the unattached end.

(2) TEST CABLES:

(*a*) Unshielded black test lead W104, either with or without alligator clip 0101 connected to the end, is used as a common connection for all DC, ohms and low frequency AC measurements, except as explained in paragraph 5(*f*), Section 4. This lead is also used in connection with milliampere measurements. In all previous measurements the pin plug of this lead should be connected to either the GND pin jack, or when it is being used for milliampere measurements, to the positive or negative MILS jack.

(*b*) For all DC voltage measurements the shielded DC cable W102 is used with its cable connector attached to the DC VOLTS connector on the main panel. For measurements to 5000 volts, Adapter E114 is attached to the end of this probe.

(*c*) For AC voltage measurements up to 250 volts, AC probe W101 is used and its cable connector attached to the AC PROBE connector on the main panel.

(*d*) The red unshielded cable W103 is used for the 1000 volt AC measurement with its pin plug end inserted in the 1000 VAC jack. This lead is also used for milliampere measurements.

(*e*) A short black unshielded lead is supplied for use as a ground connection between the R.F. probe and ground at higher R.F. frequencies, above about 30 mc.

2. ADJUSTMENT.

Warning

THE VOLTAGES WHICH ARE UTILIZED IN THIS EQUIPMENT ARE DANGEROUS TO HUMAN LIFE. BEFORE REMOVING THE EQUIPMENT FROM ITS CASE FOR INSPECTION, THE AC LINE CORD SHOULD BE DISCONNECTED FROM THE AC SUPPLY. SHOULD IT BE NECESSARY TO TAKE VOLTAGE READINGS WITHIN THE INSTRUMENT, MAKE SURE HANDS ARE DRY, USE TEST PRODS INSULATED FOR AT LEAST 1000 VOLTS, AND IN ALL POSSIBLE CASES MAKE ALL READINGS AND ADJUSTMENTS WITH ONE HAND IN A POCKET.

a. INSPECTION.—Before applying AC power to this equipment for the first time, inspect the entire equipment as follows:

(1) Make certain that all test leads, as illustrated in Figure 3-4, are in the cover of the instrument. Carefully check for mechanical damage to connectors or cables.

(2) Loosen the eight screws securing the instrument to the case and inspect chassis to make certain that all tubes are undamaged and in their proper sockets.

(3) Give the entire equipment a careful mechanical inspection to make certain there are no damaged components.

(4) Replace instrument in case.

b. TESTS PRECEDING OPERATION.—The following measurements should be made prior to placing the equipment in operation:

(1) With a continuity checker, test of cables W103, W104 and W105 should show the resistance to be approximately zero ohms.

(2) Check W102 with an ohmmeter, and the resistance from the center contact of the cable connector to the prod end should be approximately 3.3 megohms. Infinity resistance should be found between the outer part of the cable connector and the inner connection.

(3) Cable test probe W101 can be checked with an ohmmeter and should be approximately 6 ohms between pins 1 and 4. There should be infinity ohms between pin 3 and any other pin. There should be zero ohms between pin 4 and the cable connector outer shell.

(4) With the POWER switch turned ON, an ohmmeter check of the resistance between the two plugs of the AC line supply should show approximately 25 ohms. If it should vary substantially from this value or show no continuity, inspect fuses and wiring for cause of the trouble.

c. INITIATING OPERATION.—With the AC line cord connected into any convenient source of 115 volts plus or minus 10%, 50 to 60 cycles, AC, the equipment is put into operation by operating the POWER switch to ON. The PILOT light should come on immediately, and after approximately three to five minutes of warmup time the equipment should be stabilized and ready for operation.

d. REPLACING OPERATING CABLES.—When replacing the test leads and power cord in the cable compartment provided in the cover of Multimeter ME-25A/U, the following procedure should be followed (See Figure 3-3):

(1) Place the instrument face up with the cover hinged onto the case.

(2) Secure the probe section of W101 to the second clamp from the left on the cover, and insert the cable under the corner brackets in a counter clockwise direction. The male plug end of this cable is secured to the third clamp from the left.

(3) Next, place the connector end of test lead W102 in the first clamp on the left and wind the cable around the corner brackets in a counter clockwise direction.

(4) Secure the prods of test leads W103 and W104

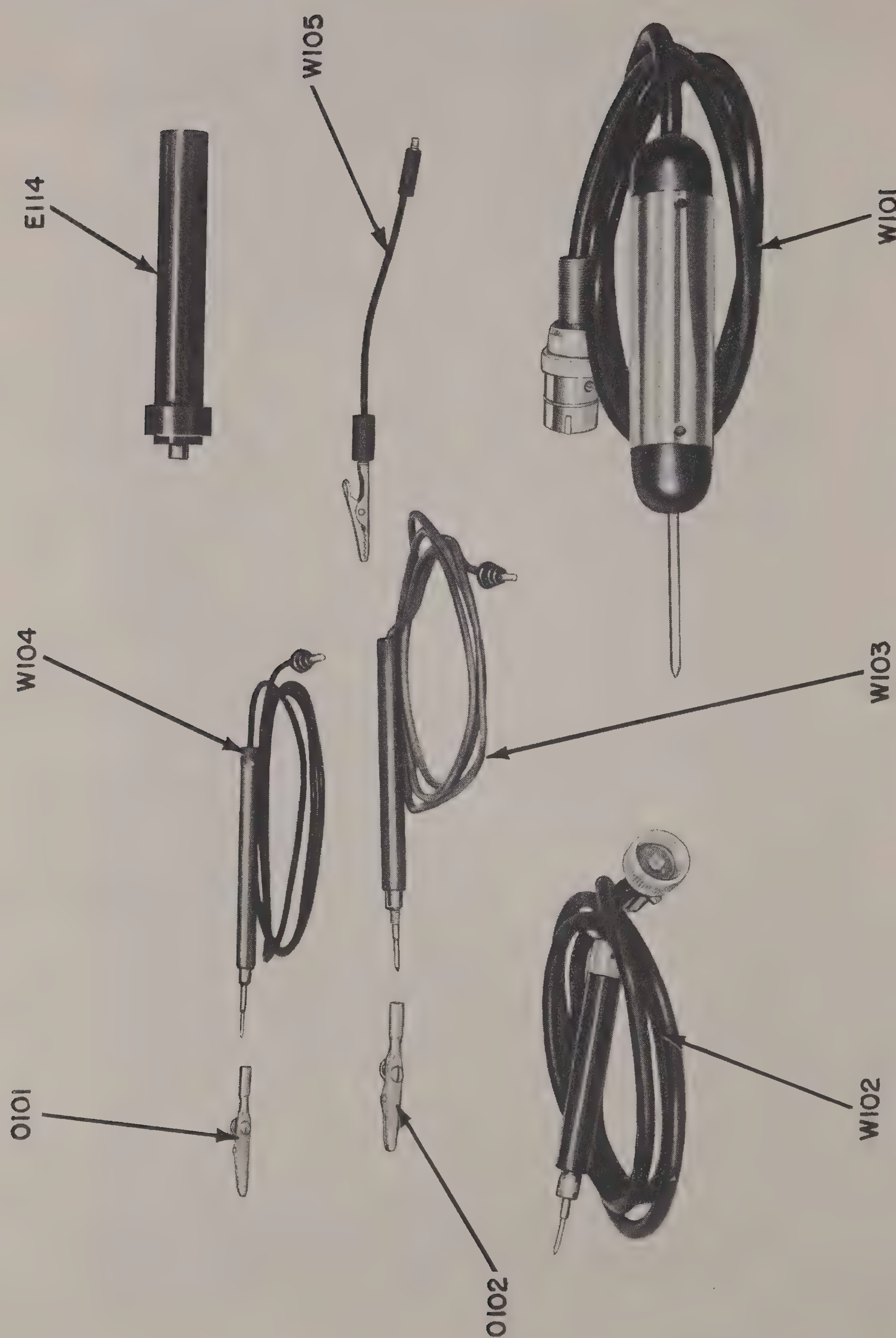


Figure 3-4. Operating Test Cables

to the bracket in the upper left hand corner of the cover compartment and wind the cables around the brackets in a clockwise direction until these two leads are completely secured.

(5) Connect the alligator clip of W105 to the prod tip of W101 as shown in Figure 3-3, and place Adapter MX-1101/U (E114) in the clamp at the extreme right of the cover compartment.

(6) The power line cord should be placed under the bracket in the lower right hand corner of the cable compartment and wound in a clockwise direction until the entire cord is secured.

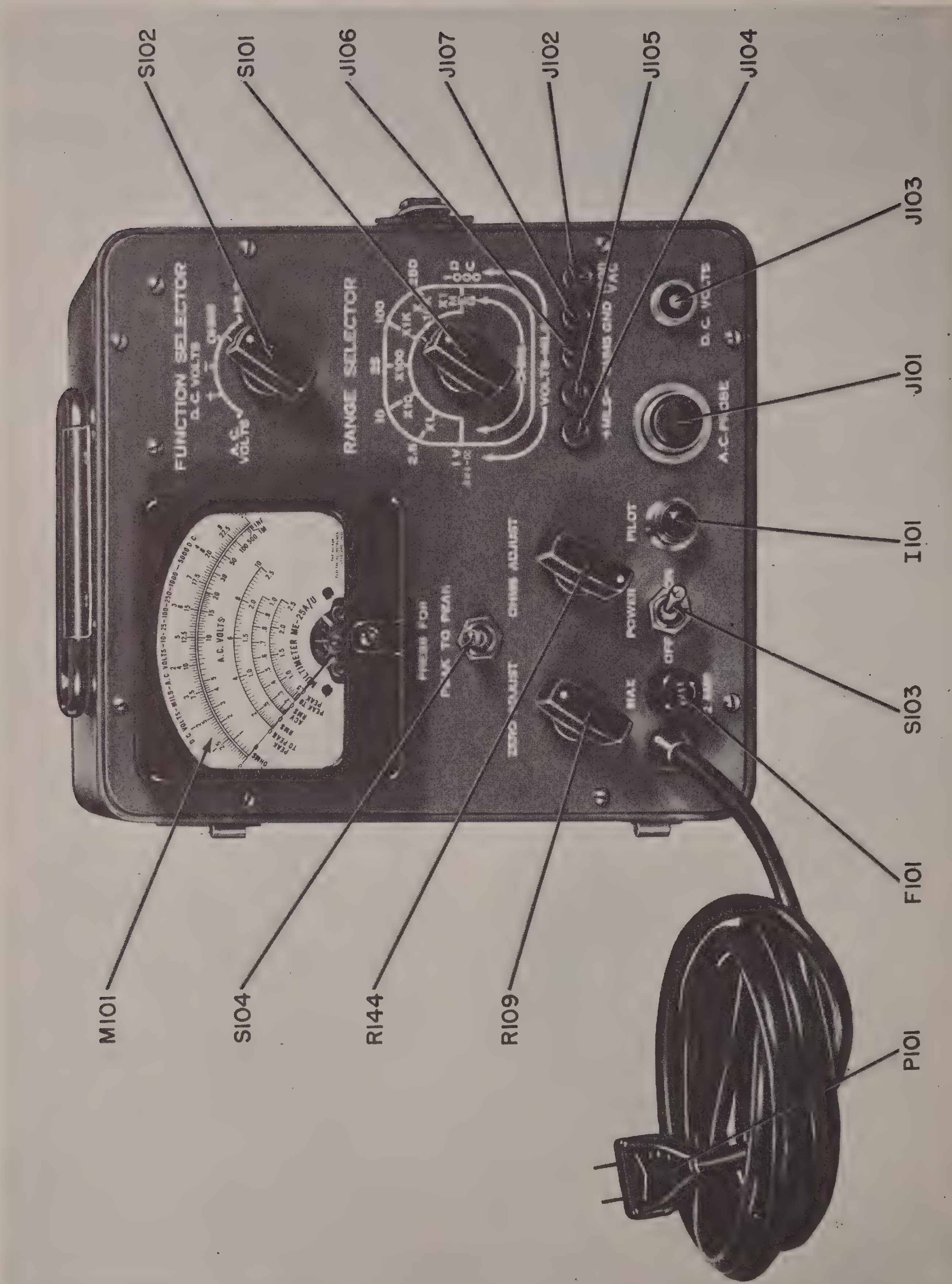


Figure 4-1. Panel Connectors and Controls

SECTION 4
OPERATION

1. FUNCTION OF EQUIPMENT.

Multimeter ME-25A/U is designed to permit the service technician to make measurements of AC voltages throughout the range of approximately 0.1 volt to 250 volts, utilizing a high impedance probe which permits measurements to be made in the frequency range of approximately 60 cycles to over 100 mc. The capacity loading of the probe is approximately 16 mmf. AC voltages may be read in terms of their RMS value or their peak-to-peak value.

AC voltages up to 1000 volts may be measured by a special jack provided. In this case the voltages are indicated in terms of their RMS value.

DC voltages from approximately 0.1 volt to 1000 volts may be measured without the use of the auxiliary high voltage adapter probe. With the use of this probe the DC voltage ranges are extended to 5000 volts. The input impedance of the DC measuring circuits is approximately 13.3 megohms for measurements up to 1000 volts, and approximately 66.5 megohms for measurements to 5000 volts.

Resistance measurements from approximately 0.2 ohms to 1000 megohms can also be made. Milliampere measurements from approximately 50 microamperes to one ampere are provided.

2. CONTROLS AND THEIR FUNCTIONS.

a. POWER SWITCH.—Operating this control to the ON position connects the internal circuits to a suitable source of supply voltage for their operation when the line cord is plugged into such suitable source.

b. FUNCTION SELECTOR.—This control connects the internal measuring circuits to permit the measurement of:

(1) AC volts, either through the probe or from the 1000 VAC jack on the front panel,

(2) DC voltages, either positive or negative with respect to ground,

(3) resistance measurements in ohms, or

(4) current measurements in milliamperes.

c. RANGE SELECTOR.—Permits the selection of various ranges of measurements as selected by the FUNCTION SELECTOR.

d. PRESS FOR PEAK TO PEAK.—This is a spring loaded switch which, in its NORMAL position, provides for AC measurements in terms of the RMS value of the voltage being measured. When pressed, measurements are then made in terms of the peak-to-peak value of the AC voltage being measured, except for th 1000 volt AC range.

e. ZERO ADJUST.—This control permits the electrical adjustment of the indicating meter pointer to zero in connection with the measurement of AC VOLTS, DC VOLTS, and OHMS.

f. OHMS ADJUST.—With test leads not connected across any source of resistance, this control is used to adjust the meter to full scale, or infinity ohms.

g. TERMINALS:

AC PROBE—Input panel connector for AC voltage measurements when using the AC probe.

DC VOLTS—An input connection for DC voltage measurements when using the DC probe.

+MILS— —Input connections for use with two unshielded leads when making milliampere measurements.

OHMS—Input connection for red unshielded lead when making resistance measurements.

GND—Common ground connection input for use in connection with ohms measurements, DC voltage measurements and AC voltage measurements.

1000 VAC—Input terminal for use in connection with the 1000 volt range AC measurements.

3. PRELIMINARY OPERATION.

a. The test leads, AC probe and cable assembly, high voltage adapter and AC power line cord are placed in the cover compartment, as shown in Figure 3-3, for storage and carrying. By removing the cover from the case the test leads are easily accessible for removal or replacement. The AC power line cord is permanently attached to the main panel.

b. To insure accurate measurements of the unknown, make sure that the meter needle rests at zero on the scale when no power is applied. This adjustment is made mechanically by means of the ZERO ADJUST screw shown on the front of the meter in Figure 4-1. Adjust until the needle rests on the zero of the AC scale.

c. Connect the AC power line cord to a source of 105-125 volts, 50-1600 cycles, AC.

d. Operate the POWER switch to ON. The PILOT light should light. Approximately three minutes are required for the tubes to heat sufficiently for stable

operation. As the power drain of the Multimeter ME-25A/U is small, approximately 12 watts at 115 volts, it is advisable, if the unit is to be used intermittently, that it be left on. The FUNCTION switch should not be left in the OHMS position.

4. CAUTIONS.

a. DO NOT ATTEMPT TO MEASURE AC VOLTAGES OVER 250 VOLTS THROUGH PROBE.

b. Measure AC voltages from 250 to 1000 by connecting W101 to the 1000 VAC jack on the front panel.

c. Voltage measurements are made with the meter across the circuit; current measurements with the meter in series with the circuit, and resistance measurements with at least one terminal of the resistor free from any associated circuit.

5. AC VOLTAGE MEASUREMENTS.

a. Operate the POWER switch to ON.

b. Connect the special AC probe and cable assembly to the panel connector AC PROBE.

c. Rotate the SELECTOR switch to AC VOLTS.

d. Rotate the RANGE switch to the correct range for the voltage under test. If this range is unknown, choose the highest range.

e. Check the electrical zero setting of the meter needle. If further adjustment of this is necessary, rotate the ZERO ADJUST knob until the needle reads zero on the AC VOLTS scale.

f. AC MEASUREMENTS.—Connect the ground lead from the GND jack of Multimeter ME-25A/U to the GROUND OF THE UNIT UNDER TEST (usually the chassis). It is desirable above 30 mc to use the short ground lead (W105) from the probe housing to the chassis of the unit under test.

g. Make connection to the unknown voltage, if under 250 volts, with the prod of the special AC probe. If the voltage is between 250 and 1000 volts, make connection with the red lead to the 1000 VAC jack, the SELECTOR switch being turned to the 1000 volt range.

h. Switch S104 should be operated to either the PEAK-TO-PEAK or RMS position, depending upon the type of voltage information desired. There is no one volt peak-to-peak range, the 2.5 volt range being the most sensitive for such measurements.

i. Read the value of the voltage from the AC scale corresponding to the position of the RANGE switch.

j. With reference to Section 2, Theory, paragraph 2*c* and Figures 2-5A and 2-5B explain the method used in which two diodes are connected in series to give a resultant indication which is proportional to the peak-to-peak value of the AC voltage being measured. In a case of a sine wave the peak-to-peak voltage delivered may be divided by 2.8 to obtain the RMS equivalent of that voltage being measured. In the case of assymetrical waves, however, this relationship no longer necessarily exists. Figure 4-2 illustrates a typical assymetric wave in which the positive excursion is 50 volts and the negative excursion 10 volts. If a half wave diode rectifier had been used and connected in the conventional manner in which the plate of the diode is fed from the AC voltage with the cathode grounded, the resulting DC voltage would be proportional to the positive excursion, or equal to 50 volts. If this type of rectification were used and the meter calibrated in terms of the equivalent RMS voltage, the meter would have indicated 50 divided by 1.4, or approximately 35.5 volts. If, however, the rectifier tube were connected as in the case of the ME-25A/U so that the resultant DC voltage were proportional to the peak-to-peak value, or 60 volts, then the resultant indication on the meter if calibrated on the basis of RMS equivalent value would have been 60 divided by 2.8, or 21.4 volts. It would be evident from Figure 4-2 that the actual RMS value of the voltage being measured would probably not be either 35.5 volts or 21.4 volts, but something considerably less than these values.

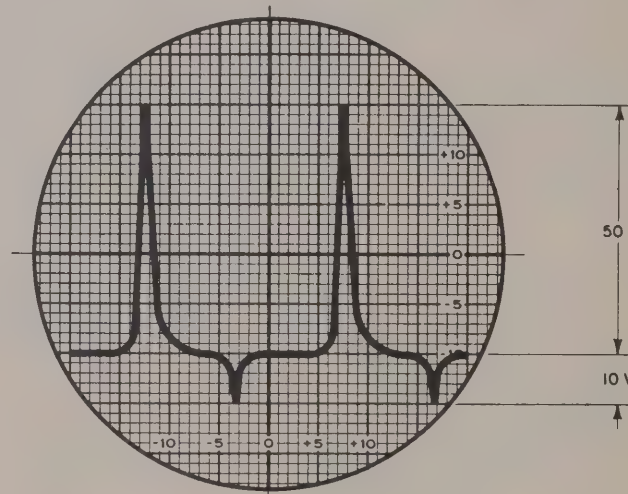
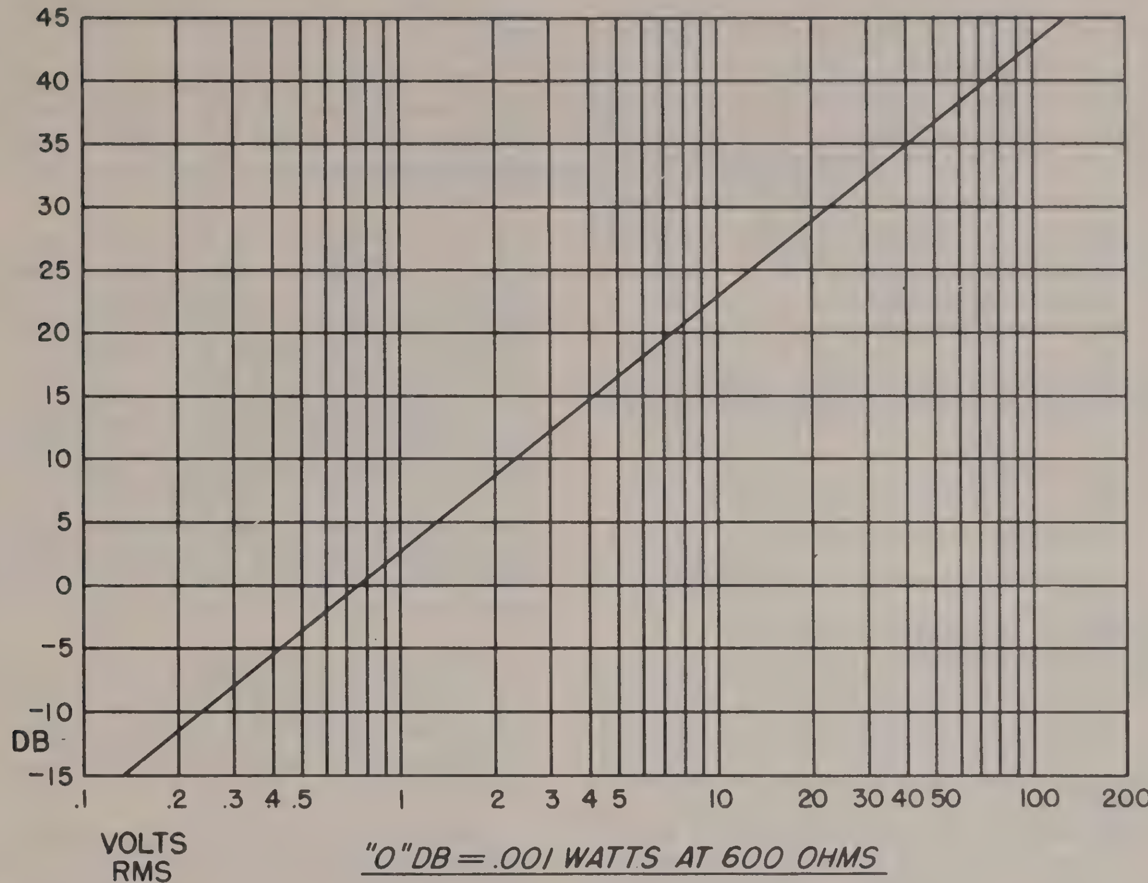


Figure 4-2. Typical Asymmetric Wave

6. DECIBEL MEASUREMENTS.

Figure 4-3 shows the relationship between decibels and voltage based on 0 DB being .001 watt at 600 ohms and .006 watts at 600 ohms. As an example, if a voltage measurement on the 600 ohm line were found to be 40 volts, the relative DB based on .001 watt level would be +35 DB. If the 0 DB level were to be based on .006 watt on a 600 ohm line, a 40 volt measurement would have indicated approximately +27 DB. In order to refer voltage measurements to other than the 600 ohm line, or to other than .001 or .006 watts, 0 DB reference, the following formula may be



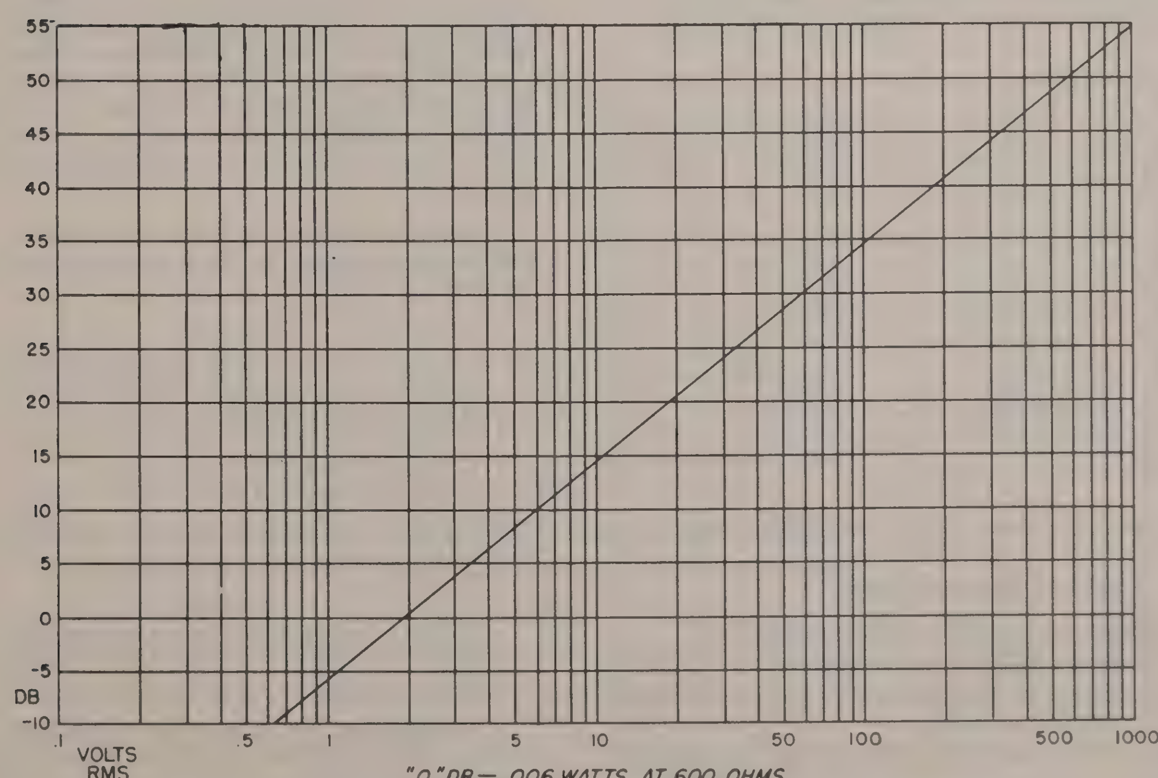


Figure 4-3. Charts Showing Relationship Between DB and Voltage

used: $DB = 20 \log \frac{E_2}{E_1}$. In this formula E_1 represents the reference voltage at a reference impedance, and E_2 represents the measured voltage. As an example, assume that the reference wattage (0 DB) is equal to 10 milliwatts, or .010 watt, and the reference impedance to be 5000 ohms. The formula $W = \frac{E_1^2}{R}$ will permit the calculation of the reference voltage for 0 DB as follows:

$$E_1^2 = (5000)\ (.01) = 50$$
$$E = \sqrt{50} = 7.1$$

To find the voltage equivalent to a +10 DB level using the original basic formula would be as follows:

$$10 = 20 \log \frac{E_2}{E_1}$$
$$0.5 = \log \frac{E_2}{7.1}$$
$$E_2 = (3.16)\ (7.1) = 22.4 \text{ volts} = +10 \text{ DB}$$

7. CORRECTION FOR DUTY CYCLES—AC VOLTAGE MEASUREMENTS.

As illustrated in Figure 4-4, nominally no correction for duty cycles would be necessary as long as the duty cycle is greater than .001. At .007 the error will be approximately 5%. For duty cycles less than this, the approximate K factor may be obtained from the chart in Figure 4-4. The true voltage with a known duty cycle can be obtained by multiplying the indicated reading by the K factor as indicated by the chart of Figure 4-4. This chart is essentially correct for repetition rates from 100 cycles to 5000 cycles.

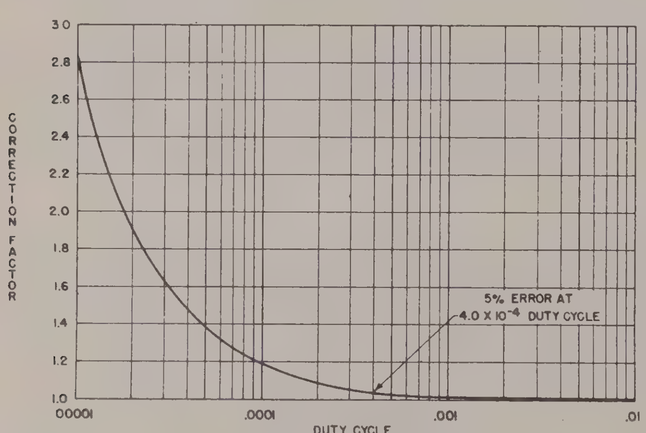


Figure 4-4. Correction Factor for Various Duty Cycles

8. DC VOLTAGE MEASUREMENTS.

a. Operate the POWER switch to ON.

b. Rotate the SELECTOR switch to +DC VOLTS.

c. Rotate the RANGE switch to the correct range for the voltage under test.

d. Check the electrical zero setting of the meter needle.

e. Connect the ground lead from the GND jack to the GROUND SIDE OF THE VOLTAGE UNDER TEST.

f. Make the other connection to the unknown voltage by means of the DC probe and read the value from the proper scale. If the meter deflects in the reverse direction, operate the SELECTOR switch to —DC VOLTS.

g. If the voltage to be measured is between 1000 and 5000 volts DC, attach the high voltage adapter MX-1101/U (E114) to the DC probe and set the SELECTOR switch to the 1000 VOLT DC position. Then read the voltage on the 0-5 scale, and multiply by 1000.

The nominal input impedance for DC measurements up to 1000 volts is approximately 13 megohms. If the voltage being measured is of sufficient magnitude to be able to read on the 5000 volt range, the installation of adapter MX-1101/U may be used to provide for an input impedance of approximately 66.5 megohms, thereby causing less loading on the circuit under test.

9. RESISTANCE MEASUREMENTS.

a. Operate the POWER switch to ON.

b. Rotate the SELECTOR switch to OHMS.

c. Rotate the RANGE switch to the correct range for the resistance under test.

d. Make sure that power is disconnected from the equipment being checked. Connect the two leads used for resistance measurements to the OHMS and GND jacks. Short the two leads and adjust the needle of the meter to zero position by means of the ZERO ADJUST control. Open the leads and adjust to full scale (INF) with the OHMS ADJUST control. Normally the infinity adjustment remains constant for all ranges. Should V101 develop any gas, it may be necessary to readjust to infinity for the highest, or X1 megohm range.

e. Connect to the resistance, making sure that one end of the resistance has been disconnected from any associated circuits.

Caution

BE SURE THAT THE OHMMETER CIRCUIT IS NOT CONNECTED ACROSS ANY SOURCE OF VOLTAGE.

10. CURRENT MEASUREMENTS.

a. Rotate the SELECTOR switch to MILS.

b. Rotate the RANGE switch to the correct range for the measurement to be made.

Caution

IF THE CURRENT IS UNKNOWN, ALWAYS START WITH THE HIGHEST MILS RANGE.

c. Connect the two leads to the +MILS— jacks and connect into the circuit, maintaining correct polarity.

d. Read the value of the current from the scale corresponding to the position of the RANGE switch.

SECTION 5
PREVENTIVE MAINTENANCE

1. GENERAL.

Preventive maintenance is the removing of possible trouble which might later cause the equipment to become inoperative. Primarily, this includes periodic inspection, checking, cleaning and tightening of contacts and components. Certain suggestions can be made for such a program, but local conditions will largely determine the exact details.

The guide to the program will be found in Table 5-1, ROUTINE MAINTENANCE CHART. By carefully following this chart, troubles can be detected and remedied before causing actual breakdown of the equipment.

2. LUBRICATION.

No lubrication is required.

3. CLEANING.

Warning

DISCONNECT POWER CORD.

a. GENERAL.—The chassis is best blown out with dry compressed air or cleaned with a dry cloth and a soft dry paint brush of suitable size. It may be necessary to use carbon tetrachloride on a cloth to clean ceramic high voltage insulators. On chassis surfaces, however, carbon tetrachloride should not be used as there is danger of softening the tropicalizing paint which covers them. Dust should be cleaned off thoroughly, both inside and outside the case.

Inspection should be combined with cleaning, since every part of the equipment can be observed at that time, and cleaning may inadvertently break or loosen a connection.

All exposed lug and screw connections, plug and socket connections, and electron tube pins should be checked for tightness. Cable ends should be properly dressed to prevent short circuits or strain on wires and lugs.

Caution

Faulty electrical contacts can cause equipment failure at a critical time. Evidences of heating or breakdown such as carbonized surfaces, overheated resistors with discolored surfaces, and discolored metal parts should be noted. Though there may be no damage, potential trouble is indicated.

TABLE 5-1. ROUTINE MAINTENANCE CHART

Warning

Before removing the case, disconnect the power cable. After removal of the case, discharge any capacitors in the power supplies.

MONTHLY

a. Remove fuses one at a time. Clean and burnish ends and clips as needed.

b. Check tube pins and socket contacts for corrosion. Clean as needed.

c. Check all tubes in a tube tester. Replace weak tubes.

d. Replace any tubes missing from tested emergency spares after first testing in proper socket.

e. Check operation of all panel controls.

f. Blow out dust with dry compressed air.

g. Check for rust and corrosion. Clean and touch up with paint as needed.

All knobs should be checked for looseness and tightened if necessary. Occasionally knobs become loose and fail to rotate their controls; thus, a loose knob may give the impression of fault in a variable circuit.

Rough handling of the instrument will sometimes jar parts or wires out of position or abrade them; such damage should be repaired. Rust or corrosion on painted surfaces should be cleaned and sanded smooth, and the spot covered with touchup paint. Unpainted surfaces will not ordinarily corrode unless exposed to salt water or some other corrosive agent. Should corrosion occur, it should be cleaned off thoroughly, taking care not to let the scrapings fall into the unit, and the spot touched up with clear varnish or tropicalizing paint. Paint or varnish should not be used too close to switch or tube socket contacts.

b. TUBES.

Compressed air or a brush will usually suffice to remove dust from the tubes. Be careful to clean tubes that operate at a high temperature, as a layer of dust would interfere with heat radiation and raise the operating temperature. After cleaning, make sure that all tubes are properly seated in their sockets and all tube clamps locked.

Tubes should be removed from their sockets periodically and the pins inspected. Any dirt and corrosion found should be removed from the pins with crocus cloth and from socket contacts with the round blade of a burnishing tool.

The plate connectors used on high voltage rectifier tubes may lose their spring tension as a result of overheating. The tension should be increased when necessary.

c. FUSES.

Fuses should be removed and checked for corrosion and looseness, either of which can cause eventual trouble. A clean cloth moistened with carbon tetrachloride will usually suffice for cleaning the fuses and clips, but in some cases it may be necessary to use crocus cloth or fine sandpaper. When replacing, make sure that the fuses are tight in their clips.

d. HIGH-VOLTAGE INSULATORS.

Ceramic and other insulators for voltages under 600 volts are usually tropicalized. They should be kept clean, but care should be taken not to remove the special paint. The use of solvents is not recommended.

Ceramic insulators for voltages greater than 600 volts are not tropicalized. They should be kept clean to prevent the possibility of arc-overs. It may be necessary to use a cloth moistened with carbon tetrachloride or some other solvent.

FAILURE REPORTS

A FAILURE REPORT must be filled out for the failure of any part of the equipment whether caused by defective or worn parts, improper operation, or external influences. It should be made on Failure Report, form DD-787-1 which has been designed to simplify this requirement. The card must be filled out and forwarded to EMAC. Full instructions are to be found on FAILURE REPORT book.

Use great care in filling the report to make certain it carries adequate information. For example, under "Circuit Symbol" use the proper circuit identification taken from the schematic drawings, such as T-803, in the case of a transformer, or R-207, for a resistor. Do not substitute brevity for clarity. Use the back of the report to completely describe the cause of failure and attach an extra piece of paper if necessary.

The purpose of this report is to inform EMAC of the cause and rate of failures. The information is used in the design of future equipment and in the maintenance of adequate supplies to keep the present equipment going. The reports you send in together with those from hundreds of other units furnish a store of information permitting EMAC to keep in touch with the performance of the equipment.

This report is not a requisition. You must request the replacement of parts in the usual manner.

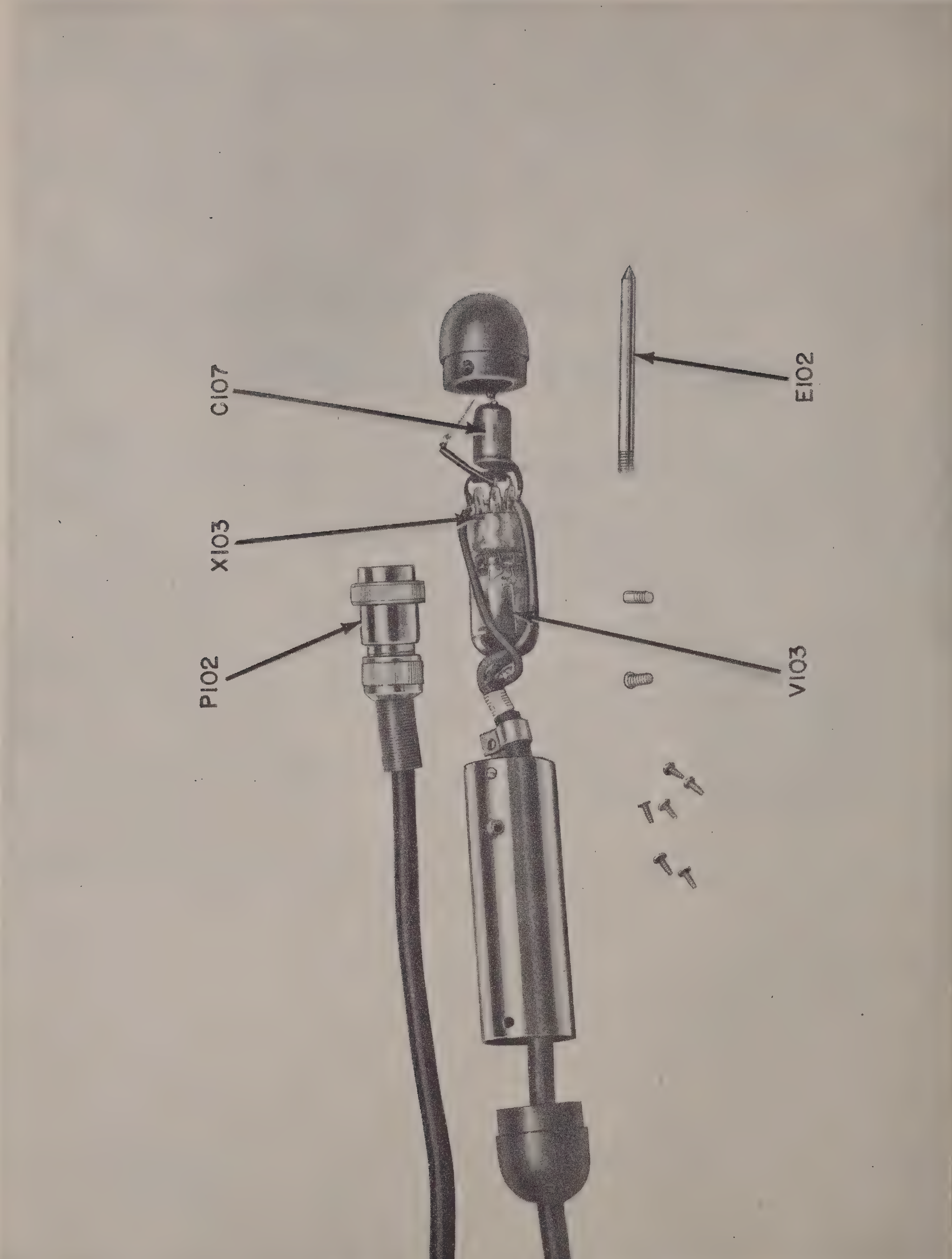


Figure 6-1. AC Probe, Cover Removed

SECTION 6
CORRECTIVE MAINTENANCE

1. REMOVAL OF CASE.

a. Remove the eight screws from the front panel.

b. Remove the case from the chassis and panel. Figures 6-3 through 6-9 are internal views of the unit showing the location of tubes and component parts.

2. TUBE MAINTENANCE.

a. In case of failure of the type 6AL5 tube in the probe, it will be impossible to adjust the meter to zero for AC voltage measurements on the lower AC ranges. This tube is readily replaced by first removing the ground clamp screw and the three small screws at each end of the metal sleeving. Then the rear plug and metal sleeving may be moved back far enough to permit removal of the tube. Figure 6-1 is a view of the probe with the cover removed.

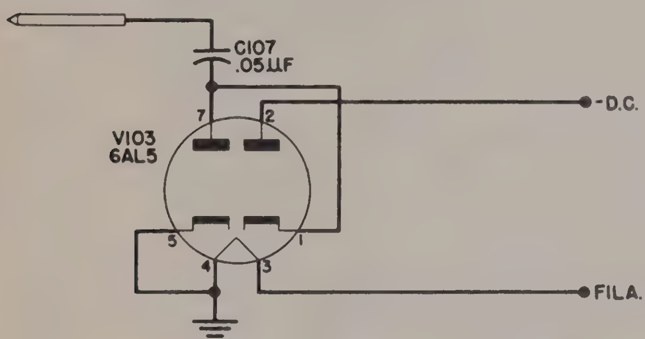


Figure 6-2. Electrical Circuits of AC Probe

b. Replace any tubes not functioning properly. The location of these tubes is shown in Figures 6-3 and 6-6. Any good tube of the same type as that employed may be used for replacement, but replacement of V101 may necessitate calibration control adjustments.

3. CALIBRATION.

a. Remove the case in the same manner outlined in paragraph 1.

b. Support the instrument with the panel in a vertical position while making calibration adjustments.

c. Plug the unit into a 105-125 volt, 50-60 cycle, AC power source. Allow a three minute warm-up period.

d. Turn the SELECTOR switch to MILS and mechanically reset the meter needle to zero if necessary.

e. AC VOLTS CALIBRATION.

(1) Adjust the meter needle to zero with the ZERO ADJUST control R109, Figures 6-3 and 6-6. No external voltage should be applied for this adjustment.

(2) Operate the SELECTOR switch to the AC VOLTS position.

(3) Turn the RANGE switch to any position. The range selected for the adjustment of calibration resistors is not important as long as a satisfactory standard voltage is available for calibration which would be covered by the range selected. With reference to the schematic wiring diagram, Figure 6-13, it will be noted that the AC calibration potentiometer R149 is connected through the PRESS FOR PEAK TO PEAK switch, S104. With this switch in the PEAK-TO-PEAK position, R150 is shorted out and AC calibration accomplished by the adjustment of R149. For this reason, in calibrating the instrument this switch should be operated to this PEAK-TO-PEAK position and calibration potentiometer R149 adjusted until the indication on the meter corresponds with the known standard of voltage being applied. In this connection, it should be noted that if the calibration voltage were, for example, 2.5 volts RMS, the indication would be 2.82 times this, or 7.05 volts on the 10 volt range.

After R149 has been properly adjusted, S104 can be returned to the NORMAL position and calibration checked to see if by measuring RMS voltages the indication is correct. If it is not correct for RMS measurements, calibrating resistor R150 should be adjusted to effect correct calibration. Changing of R150 will in no way affect the PEAK-TO-PEAK calibration since it is shorted out when measuring peak-to-peak voltages.

(4) If recalibration is required on the 1000 volt AC range, it should be effected by the adjustment of resistance R108. Resistors R105, R106 and R107 should be checked to be sure they are at their approximately correct values.

f. DC VOLTS CALIBRATION.

(1) Set the SELECTOR switch to DC VOLTS.

(2) Set the RANGE switch to the range corresponding to the known DC voltage about to be applied.

(3) Apply a known DC voltage. If the meter does not indicate the proper voltage, adjust potentiometer R145 (See Fig. 6-3 and 6-6) until the meter indicates the applied voltage. This calibration corrects for either +DC or —DC.

g. OHMS-MILS CALIBRATION.

No calibration is normally necessary on OHMS or MILS except in case of resistor failure in the dividing network. Figure 6-7 shows the RANGE SELECTOR switch and associated components.

4. DRY CELL.

One dry battery BA-30 is utilized in this instrument, and is operated as a source of DC necessary in making resistance measurements. If it is impossible to bring the meter to full scale deflection on any scale, it is probable that the voltage of the dry battery is low. To replace this:

(1) Remove the case from the chassis in accordance with paragraph 1. (See Figure 6-4)

(2) Remove the dry battery from its clamps.

(3) Replace the dry battery with a fresh cell, taking care to maintain the correct polarity.

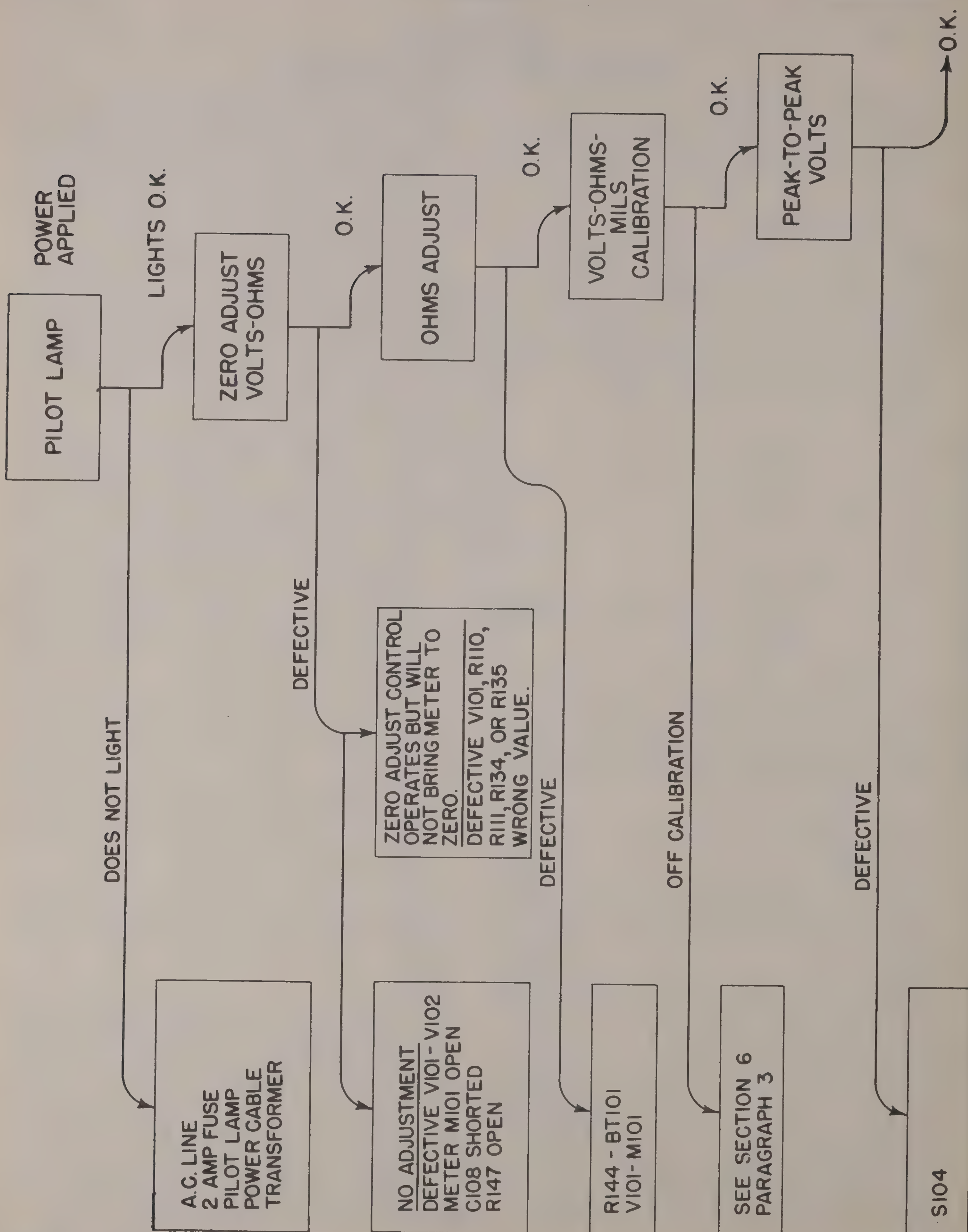


TABLE 6-1. TROUBLE SHOOTING CHART

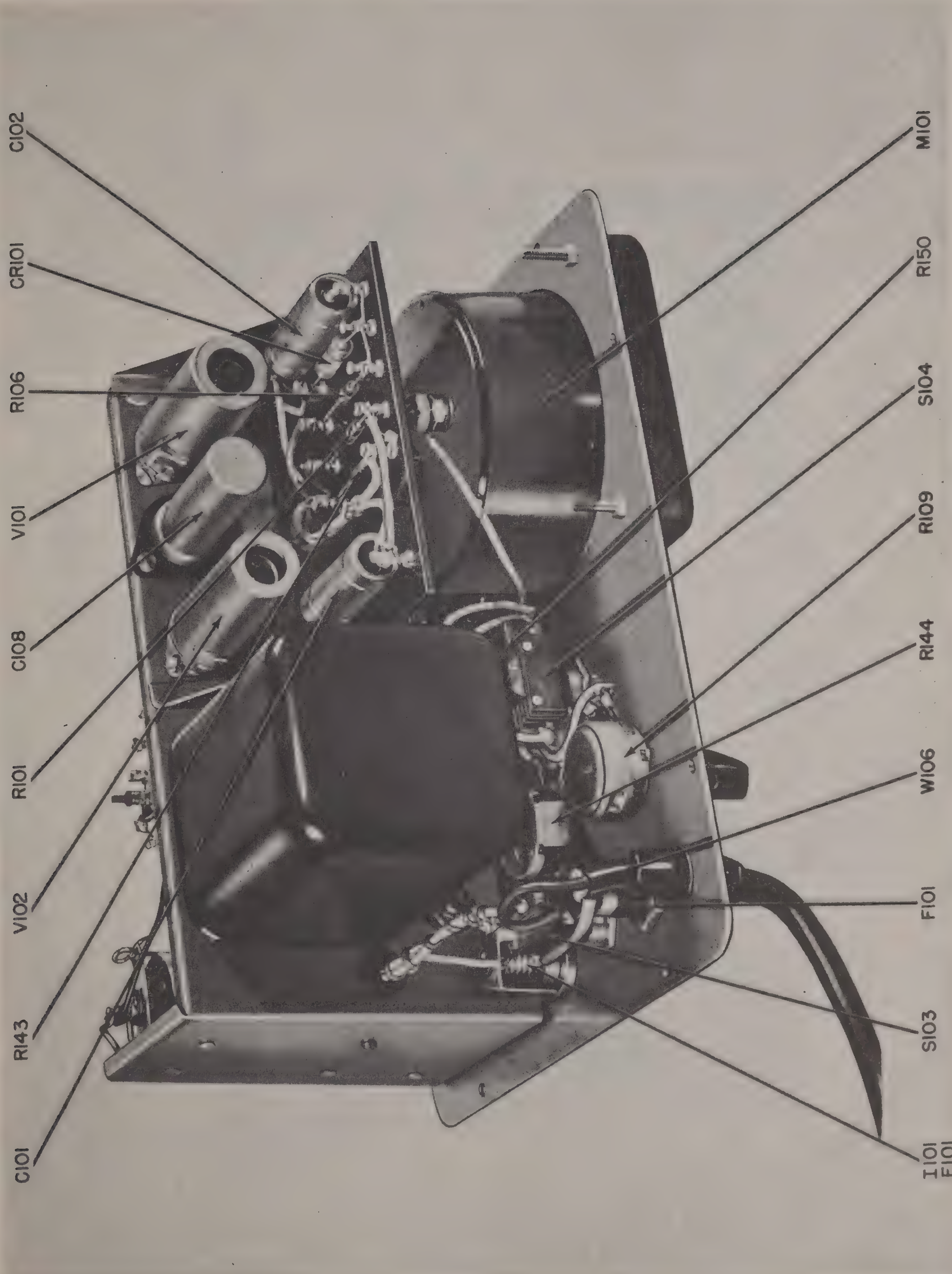


Figure 6-3. Multimeter ME-25A/U, Case Removed, Top View

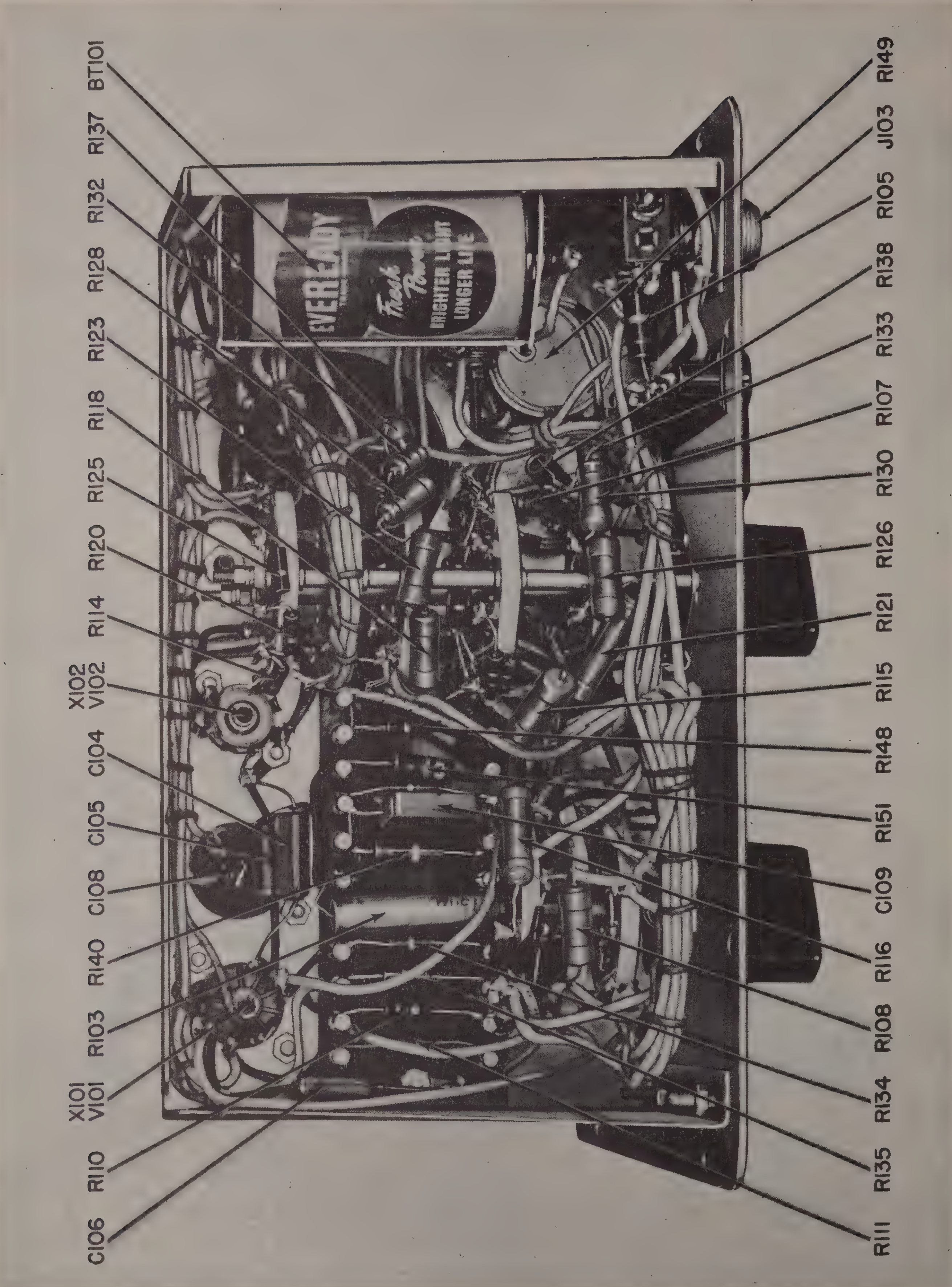


Figure 6-4. Multimeter ME-25A/U, Case Removed, Bottom View

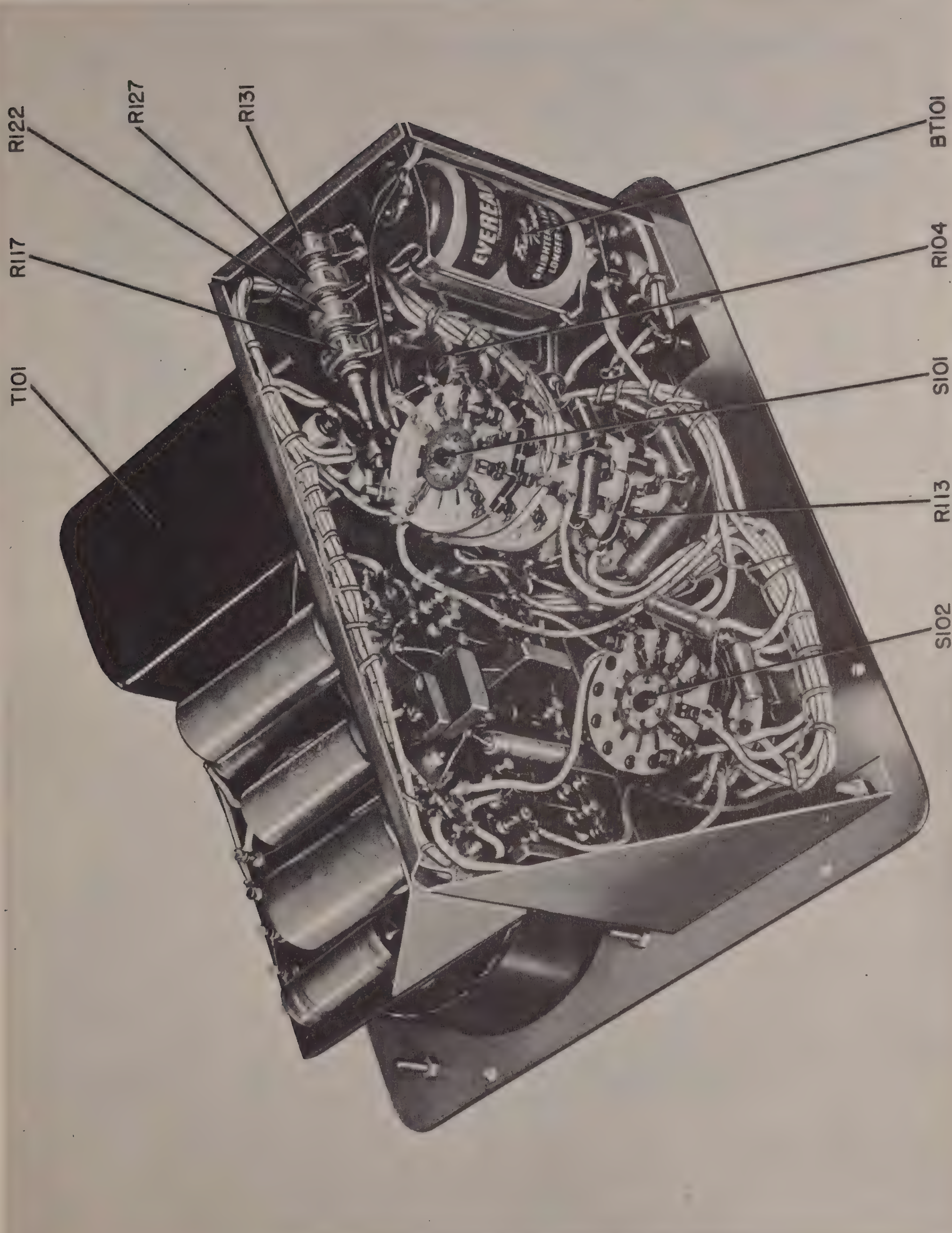


Figure 6-5. Multimeter ME-25A/U, Case Removed, Rear Oblique View

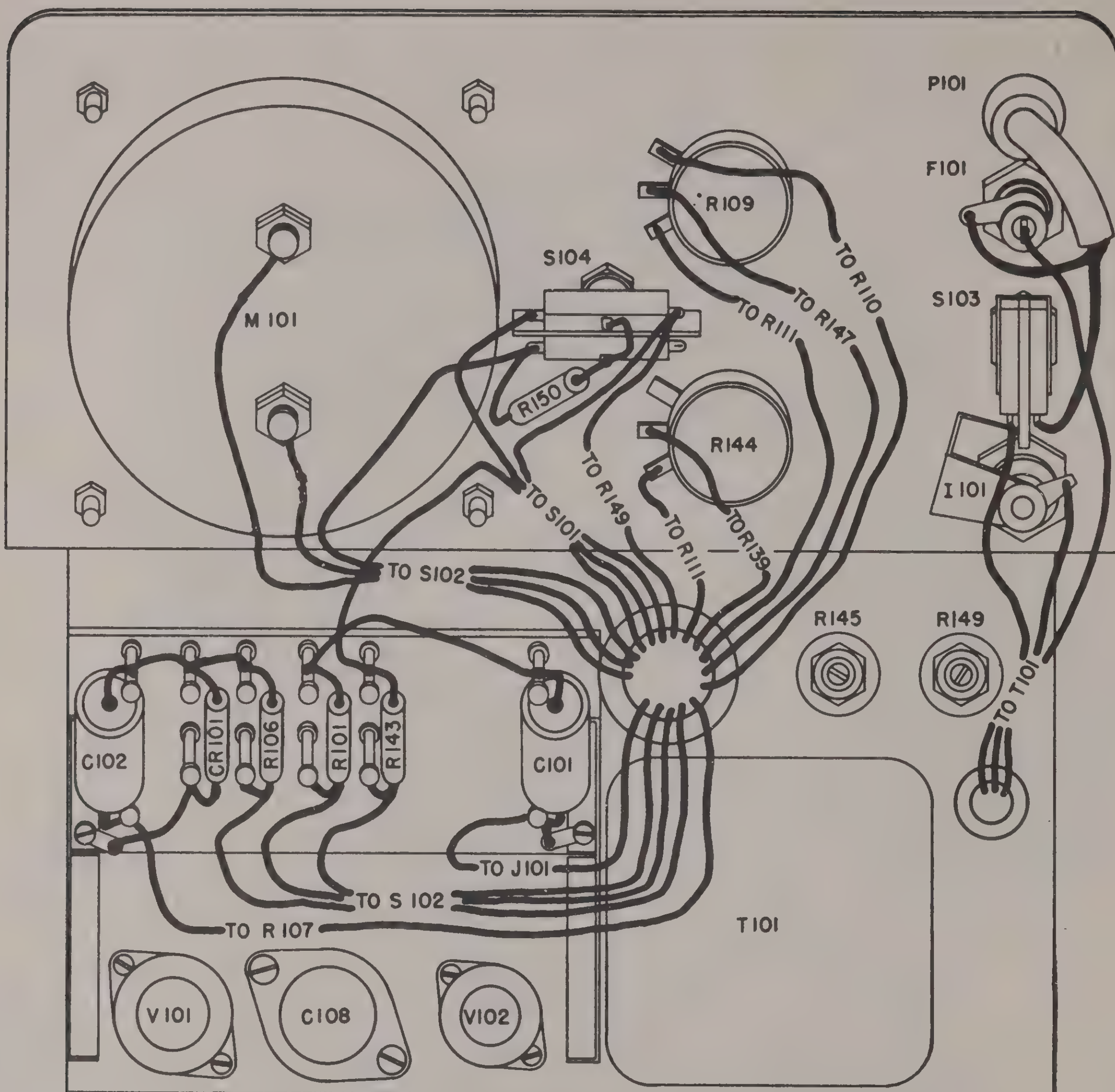


Figure 6-6. Location of Components on Upper Terminal Board
(See Inset for Perspective)

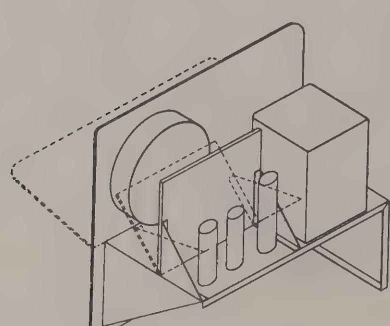


Figure 6-6. (Inset)

Figure 6-7. Range Selector Switch and Associated Components

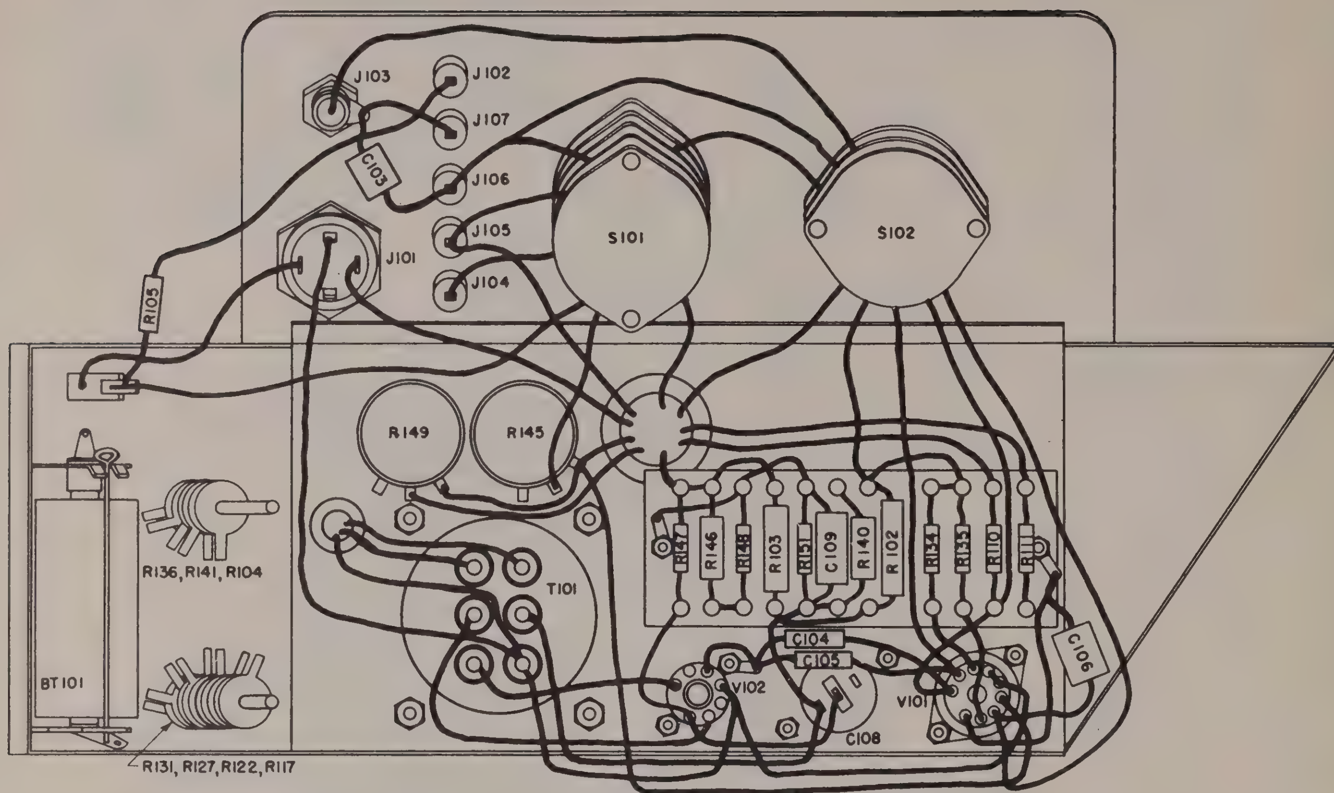


Figure 6-8. Location of Components on Lower Terminal Board (See Inset for Perspective)

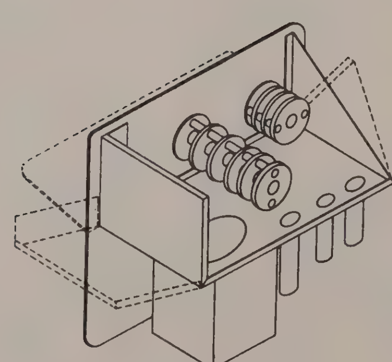


Figure 6-8. (Inset)

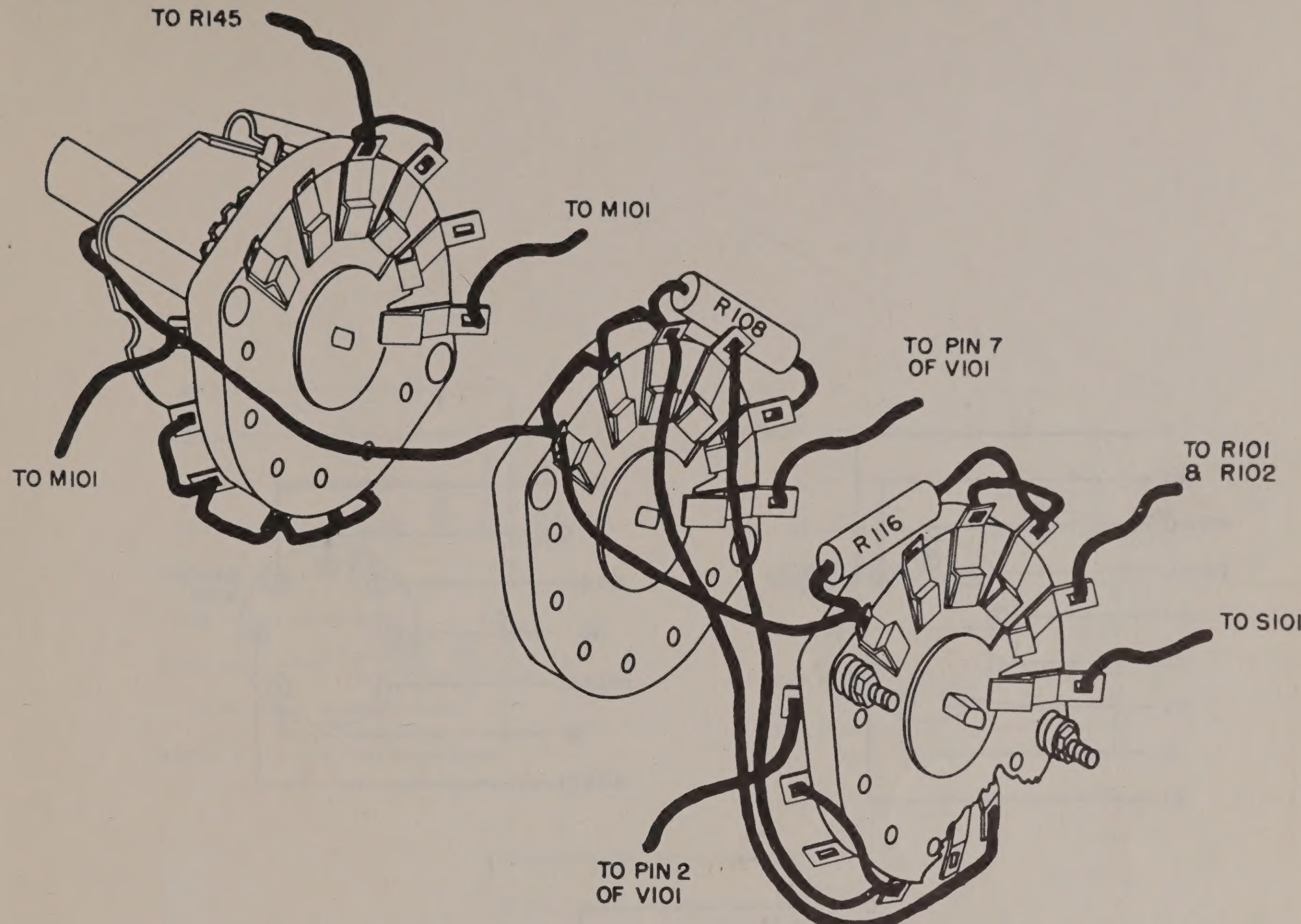


Figure 6-9. Function Selector Switch and Associated Components

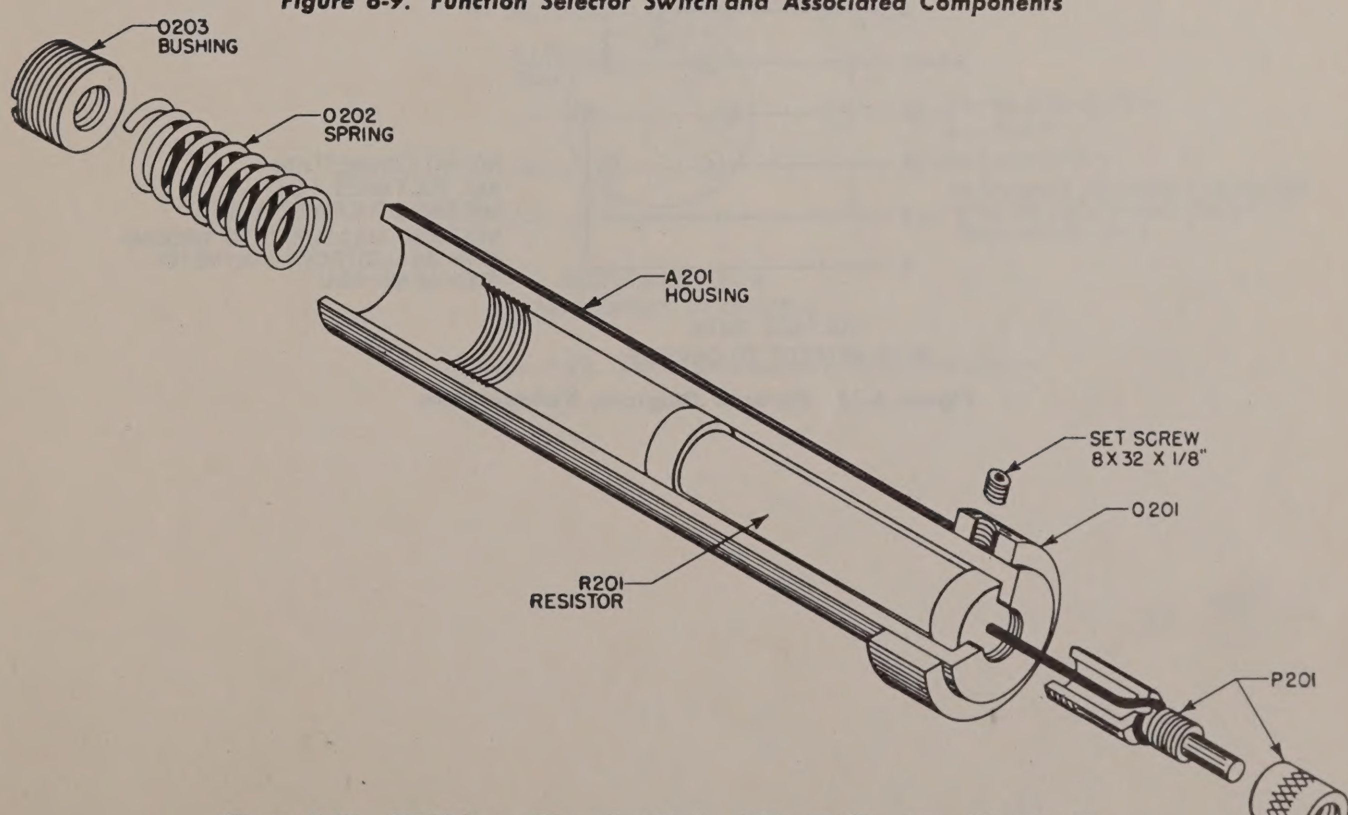


Figure 6-10. DC Voltage Extension Probe MX-1101/U, Assembly Drawing

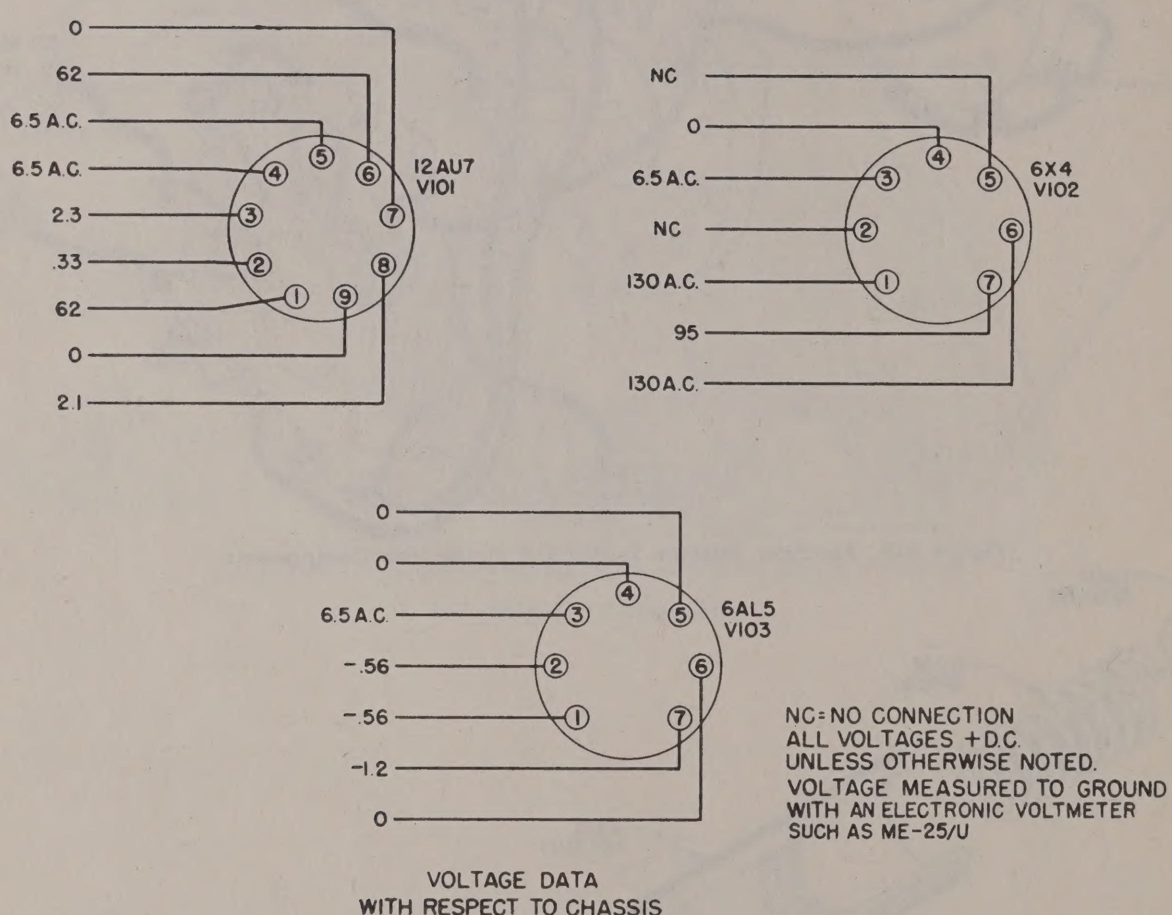


Figure 6-11. Pictorial Diagram, Voltage Data

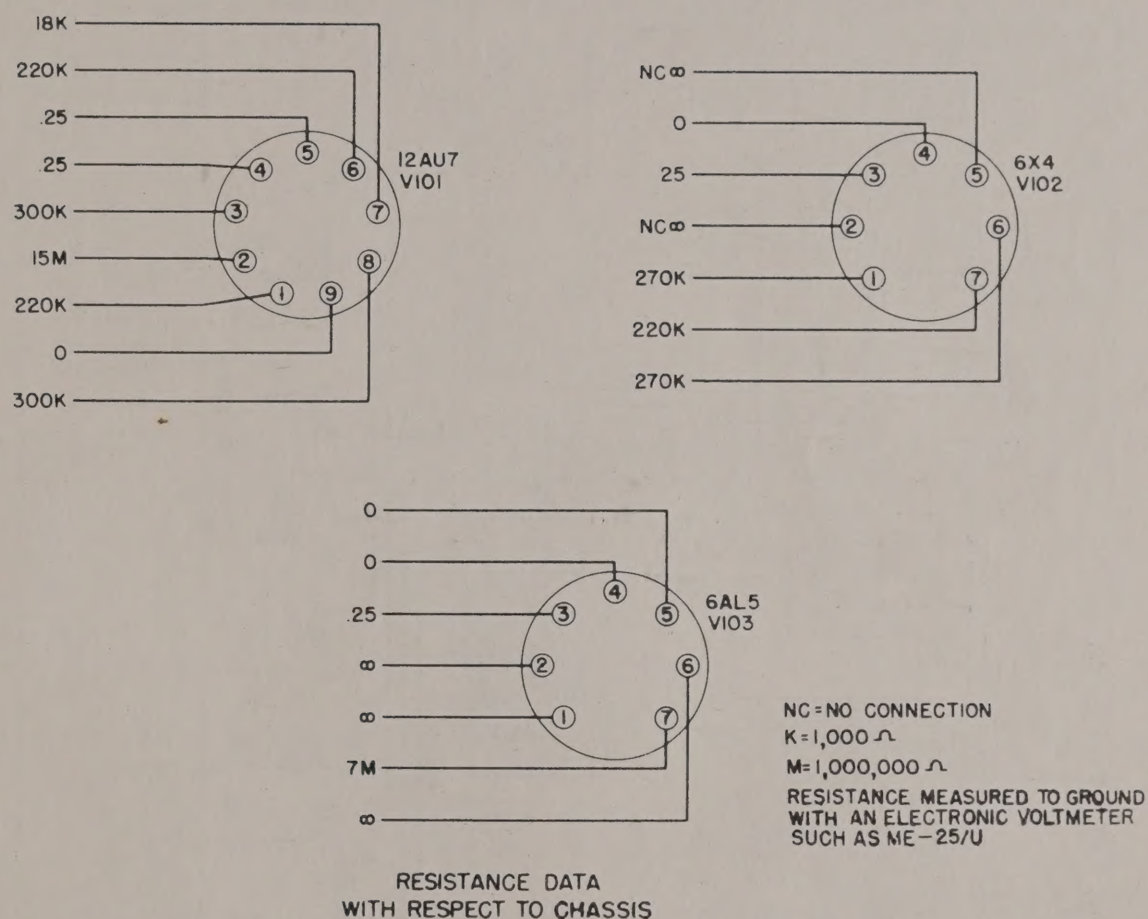
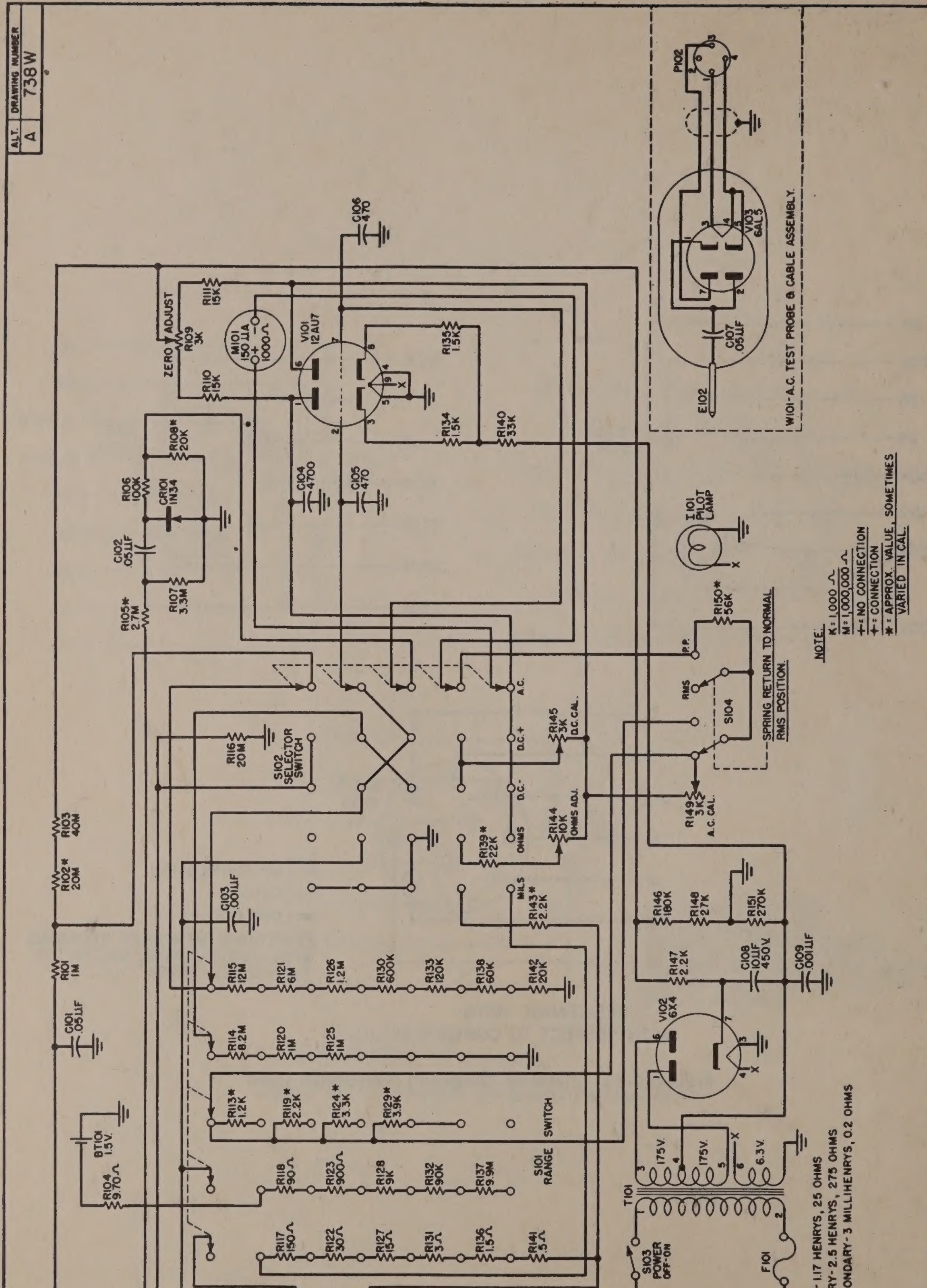


Figure 6-12. Pictorial Diagram, Resistance Data



C-103 ohms X1meg does not adjust

Figure 6-13. Schematic Diagram, Multimeter ME-25A/U